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ERRATA.

Page 125, lines 13 and 16 from bottom, *for* "Cormophyllia" *read* Comophyllia.

THE JOURNAL

OF

THE LINNEAN SOCIETY.

A Revision of the Families and Genera of the Sclerodermic Zoantharia, Ed. & H., or Madreporaria (M. Rugosa excepted). — Chapters I.–VI. By Professor P. Martin Duncan, F.R.S., F.G.S., Vice-Pres. Linnean Society.

[Read April 3, 1884.]

CHAPTER I.

Introduction. The necessity for a revision of the great groups, families, and genera of the Madreporaria, Ed. & H. The changes necessitated by the discoveries of late years, especially those of H. N. Moseley. The classification of Milne-Edwards and Jules Haime. The proposed alterations. The sections of the Sclerodermic Zoantharia, the Madreporaria Rugosa excepted. The new Families. The section Madreporaria Aporosa. The Families. Family Turbinolidæ, its subfamilies, alliances, and genera. Lists.

Introduction.—The state of confusion of the classification of the Sclerodermic Zoantharia, or the Stony Corals (the Madreporaria of Edwards and Haime), has become very intense during the last few years, and a revision of the great groups, families, and genera is really required.

No work dealing with the classification of this important Sub-order, as a whole, has appeared since the 'Histoire Naturelle des Coralliaires' by Milne-Edwards and Jules Haime, in 1860. That great work, following that of Dana on the Zoophytes of the Wilkes Exploring Expedition (1846), formed an epoch in the zoology of the Corals. It was a work of vast labour, and its

merits have been recognized by every competent critic. It revised the genera up to the date of 1857–1860, and contained descriptions of every species and its synonymy.

Since the publication of this standard work M. de Fromentel has brought out a book* which relates to fossil forms only; but all the other additions to the knowledge of the suborder have appeared in reports, monographs, and multitudes of essays, which are scattered amongst the scientific publications of Europe, America, India, and Australia. The number of new genera and species recorded has been great; and although those relating to the deep-sea and reef-building faunas have been numerous, they have been surpassed by the forms from nearly every geological formation in every quarter of the globe.

Careful morphological investigations have increased the knowledge of the minute structures of the Madreporaria; and Dana, J. Haime, L. Agassiz, Verrill, Lacaze-Duthiers, and especially H. N. Moseley, have so enlightened the views of naturalists, that very considerable changes have already been made in the primary classificatory groups of the Corals. Palæontologists and naturalists have endeavoured to assist classification by examining the solid structures; and the researches of Pourtalès, E. Pratz, Lindström, Klunzinger, and Koch have necessitated serious revision of old conceptions. It is evident, however, that the purely classificatory work has too often been attempted by some palæontologists who have not studied the recent faunas, and occasionally by naturalists who have not had experience in the details of the extinct forms.

It is proposed in this revision to omit all reference to the group of Corals called the Rugosa by Edwards and Haime.

As the synonymy of the genera which had been described up to 1860 was given by Edwards and Haime in their great work, this revision will only take it up from that date.

Only the principal sections, families, and genera are considered in this revision; species are not included. A few subgenera are admitted in the classification, and the plan of linking genera under alliances has been adopted. A certain number of alliances will be found in each subfamily or family, and usually they are fairly natural, and rarely too artificial in their nature. It will be found that some of the great groups of the Madreporaria

* 'Introduction à l'étude des Polypiers fossiles,' Paris, 1858–61

disappear, and that a very considerable number of genera are abolished.

The reasons for altering or abolishing generic diagnoses are usually stated. Some liberty has been taken with many generic descriptions; they have been rewritten, rearranged in details, and often shortened *.

The word colony has been used to describe a compound corallum.

An explanation of the morphological and structural terminology is placed at the close of the revision.

The Suborder ZOANTHARIA SCLERODERMATA, Ed. & H.

The Sclerodermic Zoantharia of Milne-Edwards and Jules Haime † are a suborder of the class Anthozoa, type Cœlenterata. According to the authors just mentioned, there are five sections of the suborder:—The MADREPORARIA APOROSA, PERFORATA, TUBULOSA, TABULATA, and RUGOSA.

It must be admitted that there is no difficulty in accepting two of these sections, with certain new limits to them, namely the Madreporaria Aporosa and the Madreporaria Perforata. The section Tubulosa no longer exists, and the section Tabulata has been eliminated by H. N. Moseley. The section "Rugosa" is not considered in this memoir.

Section MADREPORARIA APOROSA, *Ed. & H.*

In typical forms of this section the walls of the corallites are solid and the greater part or all of the septal laminæ also. There is no communication between the visceral cavities of neighbouring corallites through the theca or wall.

Section MADREPORARIA PERFORATA.

In typical forms of this section the walls and sometimes the septa are perforate, and the soft parts of one corallite

* Genera date from their time of description, not from that of simple delineation. Hypothetical genera are not recorded.

† 'Histoire naturelle des Coralliaires' (Paris, 1857–1860), vol. i.

communicate with those of their neighbours through the wall or with the outside medium.

The arrangement of the soft parts of both of these sections is not very different, and it presents a very close resemblance in most instances.

According to Milne-Edwards and Jules Haime the great family Fungidæ (Dana) is intermediate between the two sections mentioned above, and it was classified with the Aporosa. Here the difficulty of the classification of the great group begins, and I make the family Fungidæ into a section Fungida.

Dana's beautiful illustrations * and Moseley's investigations † show that the soft parts of the Fungidæ differ from those of the Aporosa and Perforata; and many years since L. Agassiz stated that a genus of the Astræidæ, according to Edwards and Haime, and one of the Aporosa had the soft structures of a Fungid and part of the hard ones also. This genus *Siderastræa* has tentacles unlike normal Astræidæ and endothecal dissepiments in addition to synapticula, and in this last respect only does it link the Aporosa and the Fungida proper together. Palæontology has shown that the genus *Thamnastræa* and others must be linked with *Siderastræa*. Hence a group of old Aporosa is placed with the section Fungida. Moreover, a genus of the recent Perforata, *Coscinaria*, has been shown to have synapticula, and many fossil forms require to be dissociated from the Perforata and placed in a group amongst the Fungida.

Hence the former family Fungidæ of Edwards and Haime becomes a section Fungida, and has associated with it two transitional families—one the Siderastræan group, or the family Plesiofungidæ, and the other the *Cyclolites* and *Microsolena* group, the family Plesioporitidæ. Zittel ‡ and E. Pratz § have paved the way largely for this suggested classification.

Section MADREPORARIA TUBULOSA, *M.-Edw. & Haime.*

The third section of the Madreporaria, according to Milne-Edwards and Jules Haime, is that of the Madrepo-

* Dana, Zoophytes, Exploring Expedition, 1846.

† Prof. H. N. Moseley, F.R.S., Report on the Corals, 'Challenger' Expedition.

‡ Zittel, 'Handbuch Palæontol.'

§ E. Pratz, 'Palæontographica,' 1882.

raria Tubulosa. Jules Haime established it in 1850, and it was fully considered by Milne-Edwards in the last volume of the 'Histoire Naturelle des Coralliaires,' 1860.

Milne-Edwards evidently had great doubts about the affinities of the two genera which were included in this section, namely *Aulopora* and *Pyrgia*, and he noticed their structural resemblances to certain Bryozoa. In 1871, after due consideration, I removed these genera out of the Zoantharia Sclerodermata, and I still hold that they are not corals *.

Section Madreporaria Tabulata, *Ed. & Haime.*

The fourth section of the Madreporaria, according to MM. Milne-Edwards and Jules Haime, is that of the Tabulata. The researches of L. Agassiz and H. N. Moseley † have eliminated the majority of the genera of this section, and have ranged them amongst the Hydrozoa and Alcyonaria. Some genera remain, but cannot form a homogeneous group, and require consideration. Milne-Edwards divided the Tabulata into four families—the Milleporidæ, Seriatoporidæ, Favositidæ, and Thecidæ. Of the first family the genus *Battersbyia* was eliminated by myself in 1867 ‡; and H. N. Moseley, during the voyage of the 'Challenger,' and in the publication of the Report on the Corals in 1876–1879, completely revolutionized the zoology of the remainder. His researches render it necessary to eliminate all the nine remaining genera.

The Favositidæ, criticized upon the data given by H. N. Moseley, have all their genera removed from the Madreporaria except some of those of the subfamily *Pocilloporinæ.*

The family Seriatoporidæ has to be broken up, and the genus *Seriatopora* is removed from the Tabulata.

Finally the Thecidæ, although the genus *Columnaria* has well-formed septa, must follow the Tabulata in the direction urged by H. N. Moseley.

So the great section Tabulata disappears, and such evidently Aporose genera of it as *Pocillopora* and *Seriatopora* should enter, according to Verrill, the Oculinidæ, or rather form a family of

* Third Report Brit. Foss. Corals, Brit. Assoc. Adv. Science (P. Martin Duncan).

† Prof. H. N. Moseley, Report on the Corals, 'Challenger' Expedition.

‡ Phil. Trans. 1867, p. 643 (P. Martin Duncan).

the Aporosa, in consequence of Moseley's discoveries of their remarkable mesenteries. Research has shown that many Madreporaria Aporosa and Perforata have tabulæ, with or without ordinary dissepiments, for instance species of *Lophohelia*, *Cyathophora*, *Astræopora*, *Favositipora*, *Alveopora*, and *Madrepora*.

With regard to the section Madreporaria Rugosa, it is necessary to eliminate certain genera of deep-sea corals, and some genera from the Secondary rocks, and to place them in the Aporosa and Perforata.

After considering the relations of the Madreporaria Aporosa, Madreporaria Perforata, and the old family of the Fungidæ, I have no hesitation in classifying the Sclerodermic Zoantharia as follows:—

Section I. MADREPORARIA APOROSA.
„ II. MADREPORARIA FUNGIDA.
„ III. MADREPORARIA PERFORATA.
„ IV. MADREPORARIA RUGOSA *.

The Great Divisions of the Sclerodermic Zoantharia or Madreporaria.

Class ANTHOZOA. Suborder ZOANTHARIA SCLERODERMATA or MADREPORARIA.

Sections:—Madreporaria Aporosa, Fungida, Perforata.

Section MADREPORARIA APOROSA.

I. Family TURBINOLIDÆ (pars), Ed. & H.
II. „ OCULINIDÆ (pars), Ed. & H.
III. „ POCILLOPORIDÆ.
IV. „ ASTRÆIDÆ, Ed. & H., amended.

Section MADREPORARIA FUNGIDA.

I. Family PLESIOFUNGIDÆ.
II. „ FUNGIDÆ, Dana (pars).
III. „ LOPHOSERIDÆ.
IV. „ ANABACIADÆ.
V. „ PLESIOPORITIDÆ.

Section MADREPORARIA PERFORATA.

I. Family EUPSAMMIDÆ.
II. „ MADREPORIDÆ, Ed. & H.
III. „ PORITIDÆ, Ed. & H.

* This section is not considered, and probably most of its genera are not Madreporarian.

Description of the Section Madreporaria Aporosa.

Section I. MADREPORARIA APOROSA, Milne-Edwards and Jules Haime, Hist. Nat. des Corall. vol. ii. p. 3 (1857–60).

The diagnosis given by these authors is positive and negative in its characters, and this was necessary, for the sections Tabulata and Tubulosa were defined at that time.

They state:—"The corals of this section are of all the Madreporaria those in which the corallum is the most perfect. A complete wall is always associated in them with a well-developed septal apparatus. The sclerenchyma which composes the corallum grows in a continuous manner, and forms laminæ of a compact tissue, in which the points corresponding with elementary nodules often project more than the rest, but are hardly ever separated by spaces even of the narrowest kind. The calices are distinctly stellate, and only present six septa when young. During development the rays formed by the upper edges of the septa become twelve in number, subsequently twenty-four, &c.; but the hexameral type remains almost always recognizable by the predominant size of the early or first septa over those of later age. The interseptal loculi are either open down their whole depth or more or less completely closed by synapticula and 'traverses.' These last may subdivide and form a series of superimposed loculi, but each one is independent of the others and they never unite to form disk-shaped laminæ, which may extend across the visceral cavity and shut it off in a series of stories as in the Madreporaria Tabulata and Rugosa" *.

Now it is evident that in some genera of this section, the septa are cribriform, and that the calices of many are polygonal or serial, or unsymmetrical in shape. Moreover the hexameral arrangement of the septa is not constant; it may be pentameral, heptameral, octameral, or decameral. It is true that tabulæ are found in a few species and genera, and that synapticula exist in genera which were not thought to have them by Edwards & Haime.

The following is the diagnosis of the Madreporaria Aporosa as now limited:—

Madreporaria with simple or colonial forms. Hard structures

* Hist. Nat. des Corall. vol. ii. p. 5.

usually solid and imperforate. Theca or wall solid, may be epithecate. Septa solid near the wall, and usually, but not invariably, solid at the further part. Interseptal loculi open throughout, or closed more or less by endotheca in the form of dissepiments, tabulæ, and stereoplasm. Calices of different shapes.

Soft parts:—One or more rows of tentacles in relation to the septa and interseptal loculi. The disk with one or more oral openings or mouths; a mesentery usually in each interseptal loculus. Septa usually in multiples of six, or variable in the number of their orders.

The sclerenchyma, or hard calcareous part of the Madreporaria Aporosa, may consist of the theca or wall of the corallite, sometimes of a common colonial wall, of septa, pali, costæ, of a columella, of endotheca or dissepiments, tabulæ or synapticula, or stereoplasm, and of exotheca, epitheca, and peritheca. There may be basal expansions or mural or epithecal rootlets. The epitheca may be free or united to the wall, or may be indistinguishable from it.

Reproduction by ova, also by gemmation from different parts of the corallum or colony, and increase may occur by fissiparity and serial growth.

Milne-Edwards and Jules Haime divided the section Madreporaria Aporosa into eight families—the Turbinolidæ, Dasmidæ, Oculinidæ, Stylophoridæ, Astræidæ, Echinoporidæ, Merulinaceæ, and the Fungidæ.

Of these families the Turbinolidæ, Oculinidæ, and Astræidæ are retained. The first includes the old Dasmidæ; the second takes in those Stylophoridæ which remain after the elimination of the true Stylasters according to H. N. Moseley. The Astræidæ absorb part of the Echinoporidæ and the Merulinaceæ.

Another family is required, that of the Pocilloporidæ, which includes the genera *Pocillopora* and *Seriatopora* of the old Tabulata, and is established upon the work of H. N. Moseley and Verrill.

The subfamilies of the Turbinolidæ of Milne-Edwards and Jules Haime, depending on the presence or absence of pali, are absorbed in this revision, and so are the two great divisions of the Astræidæ, which only depend upon the entire or dentated condition of the edges of the septa.

Section MADREPORARIA APOROSA, *Ed. & H.*

I. Family TURBINOLIDÆ *, *MM. Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. 1848, *amended.*

Corallum simple or in colonies, in the first instance reproducing by ova and in the second by gemmation from the wall or from an expansion of the basal structures. Wall solid. Septal loculi open to the base. Endotheca very rarely present.

I. Subfamily *Turbinolidæ simplices.*
Corallum simple, reproducing by ova, rarely by deciduous buds.

II. Subfamily *Turbinolidæ gemmantes.*
Colony increasing by gemmation; buds free above their origin; no exotheca uniting the corallites.

III. Subfamily *Turbinolidæ reptantes.*
Colony growing from basal expansions or stoloniferous growths; exotheca absent.

The following are the alliances of the family Turbinolidæ :—

Alliances :—Smilotrochoida, Flabelloida, Placotrochoida, Turbinoloida, Trochocyathoida, Discocyathoida, Haplophylloida.

The genus *Dasmia* stands alone.

Subfam. *Turbinolidæ simplices.*

I. Alliance SMILOTROCHOIDA.

Simple Turbinolidæ with a wall, costæ, and septa, rarely with pali. Columella absent. Epitheca present or absent.

Genus SMILOTROCHUS, Ed. & H.
 Subgenus BLAGROVIA, Duncan.
Genus ONCHOTROCHUS, Duncan.
Genus DESMOPHYLLUM, Ehr.
 Subgenus JAVANIA, Duncan.
Genus SCHIZOCYATHUS, Pourtalès.
Genus absorbed :—
 MICROTROCHUS, T. Woods.
Genera becoming subgenera :—
 BLAGROVIA, Duncan; JAVANIA, Duncan.

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* This family was divided into two subfamilies by Milne-Edwards and Jules Haime on account of the presumed morphological value of pali or paluli. The presence of pali having been shown not to be of primary importance (for they

The generic characters of *Smilotrochus*, according to Milne-Edwards and Jules Haime, were too specific. The shape of the corallum and the nature of the ornamentation are most variable quantities. The genus includes the simplest corals, and the corallite consists of a wall, costæ, and septa only; sometimes there is an epitheca.

Genus Smilotrochus, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 70 (1857), *amended.*

The corallum is simple, free in adult age, very variable in shape, base small; body straight or curved, cylindrical or conical, or cuneiform, or turbinate, compressed or not. Septa slightly exsert and free at their inner edge. Axial space vacant, there being no columella. Costæ well developed, not cristate. Epitheca usually does not exist.

Distribution.—Fossil. Cretaceous: England and Europe. Eocene: Europe, Asia. Cainozoic: Australia.

Subgenus Blagrovia, *Duncan.*

The corallum is turbinate or subturbinate, adherent; the calicular fossa is very deep; the costæ are covered with an epitheca, and the septa are very numerous.

Distribution.—Fossil. Eocene of Sind.

This subgenus absorbs the genus *Blagrovia*, nobis, Pal. Ind. ser. xiv., Foss. Corals and Alcyonaria of Sind, p. 28 (1880).

Genus Onchotrochus, *Duncan, Monog. Brit. Fossil Corals, Pal. Soc.* part ii. n. 1, p. 4.

The corallum is simple, adherent when young, free when adult, tall, slender, tubuliform, straight or hooked, or clavate. The septa are few in number, and some unite axially. The costæ are small and almost rudimentary. The epitheca is pellicular and striated. There is no columella.

Distribution.—Fossil. Cambridge Upper Greensand: Grey and White Chalk, England.

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exist in corals otherwise exceedingly closely allied, and do not appear to be of physiological importance), the subfamily Caryophyllinæ of Milne-Edwards and Jules Haime is absorbed and abolished.

About 67 genera have been arranged in this family. On revising them I find it necessary to reduce to subgenera or abolish 25, so that this family now consists of 42 genera.

The genus *Desmophyllum* was established by Ehrenberg, Corall. des Roth. Meer. p. 76 (1834). It contains many recent and fossil species, and is eminently Smilotrochoid. There is great variation in the shape of individuals of some of the species, and abnormal growths are produced around the base and from the wall by the irritation of parasites and any instability of the surface of attachment. The forms may grow to a considerable size, may adhere by their sides and form groups, and the same species will present short, long, broad-based, narrow-based, large and small caliced, costulate or non-costulate individuals.

In some instances the base extends as a film of hard matter on the supporting body, and in others there are rootlets.

The majority of species have no epitheca; but a recent form which cannot be separated from the genus has it. Moseley notices that his great *Desmophyllum ingens* is covered with an abundant dense epitheca*; and some forms of *Desmophyllum crista galli*, Ehr., sp.†, have it and others have not. But the epitheca is not separable from the wall.

Ehrenberg's definition, as given by MM. Milne-Edwards and Jules Haime ‡, is too contracted in some parts, and not sufficiently elaborate in others. As amended the genus may stand as follows :—

Genus Desmophyllum, *Ehr.* 1834, *amended.*

The corallum is fixed by a large or small base; the body may be long or short, straight, or slightly curved and twisted, with or without "rootlets" springing from the wall. Calice widely open, fossa deep; axial space vacant. Septa numerous, exsert, unequal in height, often overhanging the margin. Costæ visible near the calice, irregular, often as crests, nodules, or ridges here and there on the wall. Epitheca may or may not exist. Surface usually smooth or granular.

Distribution.—Recent. Atlantic and Pacific Oceans, Australia, Western Patagonian seas, and Mediterranean.—*Fossil.* Upper Tertiary strata of Europe.

Subgenus Javania, *Duncan, Proc. Zool. Soc. Lond.* 1876, p. 434.

The base is broad, the calice compressed, the larger septa are

* Moseley, 'Challenger' Report, p. 61.

† Duncan, Proc. Royal Society, p. 133 (1877).

‡ Hist. Nat. des Corall. vol. ii. p. 76.

exsert; the tertiaries have costæ larger than they are. The epitheca is dense near the base and pellicular near the calice, and festooned.

Locality. Japanese seas.

There is no coral closely resembling a *Smilotrochus*, *Onchotrochus*, or *Desmophyllum* which has pali. But the genus *Schizocyathus*, Pourtalès, so interesting from its budding within the calice and producing the death of the parent, comes within this Alliance.

Genus SCHIZOCYATHUS, *Pourtalès, Deep-Sea Corals, Zool. Results of the Hasslar Exped.* 1874, p. 36.

Corallum simple, without epitheca or costæ; no columella; pali in front of the last cycle of septa, united in front of the penultimate; propagating by internal gemmation.

Locality.—Recent. Caribbean sea: Atlantic, Josephine Bank, 100–760 fms.

This remarkable genus has but one species, *Schizocyathus fissilis*, in which the growth of the bud splits the parent.

The shape of the solitary species is long, conical, almost cylindrical, and the wall is marked outside by lines corresponding to the primary septa and by rows of dots corresponding to the interseptal chambers.

Lindström has described a specimen of *Schizocyathus fissilis*, Pourt., which he states has an epitheca. He states "that the wall proper between the septa consists entirely of the same sort of thin epitheca which surrounds the whole outside of the coral, or, in other words, there exists no wall as a separate formation distinct from the epitheca." It appears that there is a wall which every Turbinolian must have, and that it resembles epitheca, there being, however, no true epitheca. There is more or less stereoplasm in the interseptal loculi. The same author states that the growth is not a gemmation but an interrupted and then continued growth of the same individual*.

The genus *Microtrochus*, T. Woods, was founded upon one specimen of a very young coral. It can hardly remain in the classification, and had better drop until further evidence comes to hand regarding its mature form.

* "Contributions to the Actinology of the Atlantic Ocean," 1877, p. 18, K. Svenska Vetenskaps-Akad. Handl. xiv. No. 6.

II. Alliance FLABELLOIDA.

Simple Turbinolidæ, fixed or free, with or without rootlets, more or less compressed and flabelliform or cuneiform. Calice elongate elliptical or short. Septa large, exsert or not. Columella parietal. Costæ variable, often crested or spined. Epitheca pellicular or membranous. Rarely increasing by deciduous gemmation from the wall.

Genus Flabellum, Lesson.
　Subgenus Blastotrochus, Ed. & H.
Genus Rhizotrochus, Ed. & H.
Genus Thysanus, Duncan.
Genera absorbed:—
　　Vasilium, T. Woods; Phyllodes, Philippi; Ulocyathus, Sars.
Genus placed as a subgenus:—
　　Blastotrochus, Ed. & H.

Genus Flabellum, *Lesson, Illustr. de Zool.* 1831, *amended.*

Syn. *Vasilium*, T. Woods; *Phyllodes*, Philippi; *Ulocyathus*, Sars.

The corallum is simple, straight or bent, more or less compressed, fan-shaped. The calicular fossa is narrow and deep, usually long, rarely widely open. The columella consists of a few trabeculæ from the inner ends of the septa. The septa are numerous, and reach up to or beyond the wall. The costæ may be crested, spined, or simple. The base may be attached or may become free, broad or pedunculate. Rootlets from the wall occasional. Epitheca pellicular, rarely dense.

Distribution.—Recent. Almost universal.—*Fossil.* Eocene: Europe, Asia. Miocene: Europe, West Indies. Cainozoic: Australia and New Zealand. Pliocene: England and Europe.

This large genus is closely allied to the compressed forms of *Desmophyllum*. It may be divided into sections, which are *not* of subgeneric value however:—

1. Corallum flabelliform, subpedicellate, and becoming free. Wall nearly smooth on the two faces, and with small crests on the sides.

2. Faces of the wall with crests as well as the sides.

3. Wall with smooth faces, but with stout spines on the sides of the corallum.

4. Wall smooth, neither crests nor spines.

5. Largely fixed when young and becoming free; having spines on the sides.

6. Corallum always fixed.

Some of the deep-sea species described by Moseley have widely open calices and angular outlines. The Eocene forms ally the genus to *Smilotrochus*. *Vasilium*, Tennison Woods, a genus with one species, appears to be so closely allied to *Flabellum* that it should be absorbed*.

Subgenus BLASTOTROCHUS, (genus) *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. ii. p. 99 (1857).

Corallum simple and fixed; calice elliptical; columella rudimentary and produced by trabeculæ from the septal ends. Septa non-exsert. Epitheca smooth. Soft parts pink and red. Budding occurs at the sides between the calicular margin and the base, and the buds fall off and grow.

Distribution.—Recent. Philippines.

The parent seems to be fixed, and probably the buds get fixed after separation.

The species which have been included in the next genus are rather difficult to classify satisfactorily.

In 1848 MM. Milne-Edwards and Jules Haime described the genus *Rhizotrochus* as follows:—The corallum is simple, subpedicellated, and adheres by the means of root-like prolongations, which come from the surface of the epitheca and reach down after the fashion of adventitious roots. There is no columella. The septa are broad and not exsert, and they unite with those of the opposite side of the calice by their inner ends.

The typical species was *Rhizotrochus typus*, Ed. & H., from Singapore (*op. cit.* vol. ii. p. 98). It has a succession of hollow rootlets, an epitheca which permits the costæ to be seen under it, and a very deep compressed calice.

In *Rhizotrochus affinis*, nobis (Madrep. Deep-Sea, H.M.S. 'Porcupine,' Trans. Zool. Soc. Lond. vol. viii. pt. v. p. 323, 1873), the epitheca comes up to the very margin, is striated and coarse, yet is inseparable from the wall and, indeed, not to be distinguished from it. The radicles are large and are offshoots of the epitheca. The coral without the radicles is very closely allied to the broad-based, slightly compressed *Flabellum rubrum* from New Zealand.

* T. Woods, Proc. Linn. Soc. New South Wales, vol. iii. 1878–79, p. 43.

Rhizotrochus fragilis, Pourtalès (Deep-Sea Corals, Illustr. Cat. Mus. Comp. Zool. Harvard, 1871, No. iv. p. 17). The septa of the 1st and 2nd orders meet in the centre of the deep fossa, and the corallum has an exquisitely fine pellicular epitheca ornamented with curves and vandykes, which is not to be distinguished from a wall. There is no theca in the ordinary sense. The rootlets are small, and their cavities are continuous with those of the interseptal loculi.

Rhizotrochus tulipa of the same author (Hasslar Corals, 1874, p. 39) has exsert septa besides the rootlets; otherwise it resembles the other species.

Now the species are clearly divisible into those with a well-developed rough epitheca and those without one, and in the latter instance the wall is really epithecate. It is by no means sure that the rough epitheca is not mural.

Genus Rhizotrochus, *MM. Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 97 (1857), *amended.*

Corallum simple, tall or short, cylindrical, compressed more or less, and with a compressed or circular calice. Calice with a deep fossa and thin septa, which are usually not exsert and never much so. The columella is absent, and the septa either unite by a few trabeculæ or join across the axial space. The wall is very thin, and resembles pellicular or opaque epitheca. Costæ rudimentary or absent. The epithecate wall is produced in the form of rootlets, which are hollow and communicate with the visceral cavity. Corallum attached by the rootlets and base.

Localities.—Recent. Mediterranean; Florida seas; Pacific.

Genus Thysanus, *Duncan, Quart. Journ. Geol. Soc.* vol. xix. 1863, p. 430, *amended.*

Corallum simple, becoming free with age. Elongate, compressed, low, pedicellate at one end of the long base. Calice long, narrow, shallow, elongate, elliptical. Septa numerous, radiating more or less from the end of the calice, which corresponds with the basal pedicel, granular, minutely spinulose. Columella small, parietal. Costæ well developed, converging to pedicel, granular, minutely spined. A groove may or may nct traverse the base. Epitheca variable.

Distribution.—Fossil. Miocene: West Indies.

III. Alliance PLACOTROCHOIDA.

Simple Turbinolidæ, free or attached, compressed, with an essential, more or less lamellar or elongate columella, rarely with pali.

Genus Placotrochus, Ed. & H.
Genus Sphenotrochus, Ed. & H.
Genus Nototrochus, Duncan.
Genus Placocyathus, Ed. & H.
Genus Platytrochus, Ed. & H.

Genus Placotrochus, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 282 (1848), *amended.*

The corallum is simple, straight, cuneiform, flabelliform, and compressed or cornute, or more or less cylindrical and compressed. The columella is essential and is lamellar, horizontal, sharp, and entire at the surface, or crenulated. Septa exsert or not. Costæ developed, and often in crests or spinulose.

Localities.—Recent. Chinese seas, Philippines, N. Australia.—*Fossil.* Miocene of West Indies, Australia, Europe.

This is a well-marked genus, and some of the species are much compressed and extended laterally; others are deltoid and compressed; and one Sicilian form is cornute, with an epitheca. The lamellar and essential columella is very characteristic.

Genus Sphenotrochus, *MM. Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 65.

The corallum is free, straight, cuneiform, compressed. Septa exsert or not; the principal reach the essential lamellar columella, which is lobed or knobbed at the free surface on the floor of the elliptical calice. Base bluntly pointed, truncate, or emarginate. Costæ projecting straight or more or less in zig-zag. Lateral costæ crested or not.

Localities.—Recent. Mediterranean and N. Africa; coast of Brazil; European coasts of N. Atlantic; S. Australian coasts.—*Fossil.* Cretaceous: Germany. Eocene of France, Belgium, and Alabama. Miocene of France and Germany. Pliocene of England. Cainozoic: Australia and New Zealand.

The species described by M. de Fromentel from the Cretaceous of France would appear to be more like a *Placotrochus* than a *Sphenotrochus*.

There is a common little simple coral in the Tertiaries of Australia which has given the Rev. T. Woods and myself much

trouble. It was at first placed in the genus *Turbinolia*, then in *Caryophyllia*, then in *Deltocyathus* and in a new genus of Mr. Wood's, *Notocyathus* *. Fortunately some excellent specimens have lately come to hand, and there is no doubt that the projection of the tertiary septa in front of the secondaries is not a palus but a paliform lobe. There is a decided columella with nodules upon it. The form *Caryophyllia viola*, Woods and Duncan, must come under a new genus, *Nototrochus*.

Genus NOTOTROCHUS, gen. nov.

Syn. *Notocyathus*, Woods.

The corallum is cuneiform, compressed, free, with a widely open elliptical calice. Columella formed by the septal ends and by intermediate solid tissue, elongate, more or less lobed or nodular where free. Septa unequal, arched near the margin; primaries longest; secondaries shorter than tertiaries, joining these last by lateral processes and by inner end also. Tertiaries uniting in front of secondaries, and joining with an offshoot of the columella, which is produced as a paliform lobe. Paliform lobe before primaries also. Costæ vary in length, trifurcating low down, subequal at the calice; interseptal spaces wide.

Distribution.—Fossil. Tertiary: Australia, New Zealand.

Genus PLACOCYATHUS, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 328 (1848), *amended.*

The corallum is simple, free or fixed, pedicellate, or with a broad adherent base. Shape more or less flabellar, curved or straight, compressed. Septa exsert or not. Columella lamellar. Pali in more than one crown, usually only before the penultimate and antepenultimate cycles, but occasionally only before the larger septa, and before all the cycles except the last. Costæ visible or not; with or without epitheca.

Distribution.—Recent. Position unknown.—*Fossil.* Eocene of Sind, Asia. Miocene of Antilles.

The genus, as amended, combines all the species of *Placocyathus* very naturally.

* Palæont. of New Zealand (Wellington), Cat. Mus. Geol. Survey Dep. pt. iv. (1880).

Genus PLATYTROCHUS, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 246 (1848).

The corallum is simple, straight, cuneiform, and non-adherent. The collumella is essential, elongate, and fascicular, and has a free papillary edge. The septa are broad and exsert. The wall is naked, and there are two kinds of costæ: those on the middle of the broad surfaces of the corallum enlarge towards the calice, and those on the edges of the corallum near the base are extended and large. The compressed base is with or without a conical point.

Distribution.—Fossil. Eocene: Alabama.—*Recent.* Australian seas?

This genus was founded to include two species from Alabama which had been placed by Lea amongst the Turbinolians, and one of them in the genus *Endopachys* by Lonsdale. The forms are remarkable, and very Placotrochoid in appearance. There is, however, a lamellar fascicular columella, and the extension of the costæ is almost unique.

IV. Alliance TURBINOLOIDA.

Simple Turbinolidæ, free or attached, straight, conico-cylindrical, rarely cornute. Septa uniting more or less with a styliform columella which projects. Some forms with pali, with or without a columella.

Genus TURBINOLIA, Ed. & H.
Subgenus STYLOTROCHUS, E. de From.
Genus STYLOCYATHUS, d'Orb.
Genus CONOCYATHUS, d'Orb.
Genus BISTYLIA, Tennison Woods.
Genus TREMATOTROCHUS, Tennison Woods.
Genera absorbed:—PLEUROCYATHUS, Keferstein, by STYLOCYATHUS, d'Orb.; STYLOCYATHUS, Reuss, =STYLOCYATHUS, d'Orb.

Stylotrochus becomes a subgenus.

Genus TURBINOLIA, *MM. Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 60.

The corallum is simple, free, straight, and conical, rarely curved or cornute. The calice is circular in outline. The columella is essential, and projects in the calice like a stylet. The septa are exsert. The costæ are lamellar and project, are straight and perfect. Intercostal spaces with or without fossettes.

Distribution.—Fossil. Eocene: England, France. Oligocene: Germany.—*Recent.* Caribbean Sea?

There is a very marked facies in all the species of *Turbinolia*, which are eighteen in number, eleven having lived on the English area during the Eocene. There are three species recorded from the Lower Oligocene of Germany.

The number of septa is not great, and the species may be grouped under four heads :—Those with four cycles incomplete; those with three cycles; those with three cycles of septa and the costæ of a fourth cycle; and those with the third cycle of septa incomplete. The columella is a styloid process arising from the base within, and some septa always unite with it.

The genus is comparatively isolated; some species of the genus *Sphenotrochus* resemble some of the *Turbinoliæ* with stout costæ, but the other distinctions are evident.

There is a genus of M. de Fromentel's, which was established from a single specimen of one species. It only differs from *Turbinolia* in having a curved cornute corallum and no "fossettes" between the costæ. This last character is not invariable in the genus *Turbinolia*. This genus *Stylotrochus* (Pal. Franç., Zooph. Crét. pl. viii.) is of Cretaceous age, and I place it as a subgenus.

Sismondi names a species from the Italian Tertiaries.

Genus Stylocyathus, *d'Orbigny, Note sur les Polyp. foss.* p. 5 (1849).

Syn. *Pleurocyathus*, Kefst. (de Fromentel, Pal. Franç., Zooph. Terr. Crét. pl. viii.).

The corallum is subturbinate, subpedicellate, curved, and free. The columella is styliform or compressed. The septa are exsert, and there are pali before all the cycles except the last. An epitheca is well developed, and extends more or less to the calicular margin.

Distribution.—Fossil. Cretaceous, Eocene, Oligocene: Europe.

Pleurocyathus, Kefst., is not generically distinct from the above. It is straight, free, has costæ which are smooth, and a styloid columella. The only distinction is the presence of the epitheca in *Stylocyathus*, d'Orb. Reuss named *Pleurocyathus Stylocyathus*, having been unaware of d'Orbigny's genus (see also pages 26 and 27 of this Revision).

There is a great difficulty in placing the next genus with any of the alliances of the Turbinolidæ; and it had better come in as one of the Turbinolian alliance.

Genus Conocyathus, *d'Orbigny*, 1849.

The corallum is free, conical, trochoid, straight, the costæ are sublamellar, the septa are exsert and strongly echinulate on the sides. The columella is absent; and there are pali before the penultimate cycle of septa.

Distribution.—Fossil. Miocene of Mayence; Cainozoic, Australia.—*Recent.* South-Australian and New-Zealand seas.

Genus Bistylia, *Tennison Woods, Trans. Phil. Soc. Adelaide, S. Australia*, 1877–78, p. 114.

Corallum simple, conico-cylindrical, attached. Columella a double style.

Distribution.—Fossil. Tertiary deposits of Australia.

There is much difficulty in placing the next genus; and indeed it would be insuperable were it not for the admirable drawing of one of the species. The description of the genus *Trematotrochus* by Tennison Woods is very short; but the light thrown on it by the illustration is very, but not perfectly, explanatory.

Mr. Tennison Woods differentiates as follows:—

Genus Trematotrochus, *T. Woods, Proc. Royal Soc. New South Wales*, vol. xii. 1878, p. 59, fig. 2.

"Corallum free; visceral chambers free. Septa distinct, only united in the middle. Pali exsert. No endotheca or synapticula. Wall perforated."

The figure and the description of the species indicate that the septa are stout, not perforate, and that the perforations are perfectly symmetrical, and in the intercostal spaces only. The "pali" are not more than paliform lobes or dentations around the circular axial space which is bounded by the united inner (not middle) ends of the septa. The appearance is that of a species of *Turbinolia* or *Conocyathus*, with the costæ not so projecting as is usual. The intercostal dimples of the *Turbinoliæ* of the Eocene of Bracklesham do not perforate; and they are on either side of a line running down the intercostal spaces; but the wall is very thin, and often wears away during fossilization. The arrangement of the septa in *Trematotrochus* is, however, different from that of any species of *Turbinolia*.

The form described by Mr. Tennison Woods may then be thus described generically :—

Genus TREMATOTROCHUS, *T. Woods, amended.*

Corallum simple, regularly conical, elongated, free. Calice circular, with a well-developed margin. Columella none. Septa few, short; those which are large and equal extend close to the axial space, and form a tube-like space. A cycle of rudimentary septa corresponds to costæ which are nearly as large as those of the other septa. Paliform nodules on the primary septa. Intercostal spaces regularly fenestrated? Neither endotheca nor synapticula exist.

Distribution.—Fossil. Miocene or Cainozoic: Australia.

V. Alliance TROCHOCYATHOIDA.

Simple Turbinolidæ, with wall, costæ with or without epitheca. Pali in one or several crowns, or absent. Columella fasciculate. Shape variable.

Genus TROCHOCYATHUS, Ed. & H.
  Subgenus TROPIDOCYATHUS, Ed. & H.
  Subgenus THECOCYATHUS, Ed. & H.
  Subgenus BLANFORDIA, Duncan.
Genus DELTOCYATHUS, Ed. & H.
Genus ODONTOCYATHUS, Moseley.
Genus LEPTOCYATHUS, Ed. & H.
Genus PARACYATHUS, Ed. & H.
Genus HETEROCYATHUS, Ed. & H.
Genus CARYOPHYLLIA, Lmk.
  Subgenus ACANTHOCYATHUS, Ed. & H.
Genus STENOCYATHUS, Pourtalès.
Genus CERATOTROCHUS, Ed. & H.
Genera absorbed :—
  APLOCYATHUS, d'Orb.; STEPHANOCYATHUS, Seguenza; PLATYCYATHUS, E. de From.; BATHYCYATHUS, Ed. & H.; DUNOCYATHUS, T. Woods; BLASTOCYATHUS, Reuss; CONOTROCHUS, Seguenza; EPITROCHUS, E. de From.; PLEUROCYATHUS, Moseley, Keferstein, and E. de Fromentel; CRISPATOTROCHUS, T. Woods.

The genera *Tropidocyathus*, Ed. & H., *Thecocyathus*, Ed. & H., *Blanfordia*, Dunc., and *Acanthocyathus*, Ed. & H., become subgenera.

The Trochocyathoid alliance is a large one, and contains genera which have persisted from the age of the Lias to the present time;

others which have endured from the Cretaceous age to the present day, and some which flourished during the Eocene and still exist. Some genera are dwellers in the deep sea. Any turbinate-shaped species of the genus *Trochocyathus* and any form of the genus *Ceratotrochus* may be taken as the types of the two great groups of the alliance, the one with and the other without pali.

Genus Trochocyathus, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 300 (1848), *amended.*

Syn. *Aplocyathus*, d'Orb.; *Stephanocyathus*, Seguenza; *Platycyathus*, E. de From.

The corallum is simple, pedunculate or subpedicellate, or merely shows the trace of a former adhesion. The shape may be elongate, turbinate, subturbinate, straight, curved, compressed or not, or more or less discoid and flat. The calice is deep or widely open. The septa are long and usually some are exsert. The pali are in two crowns. The columella is formed of trabeculæ, is essential, and may or may not be papillary. The costæ may or may not be well developed, crested, spined, or simply projecting. Epitheca variable.

Distribution.—Fossil. Lias to Recent. *Fossil forms* worldwide.—*Recent.* West Indies, South-Australian seas.

The genus is a large one, and should include some subgenera. Its species have been divided into the following groups by Milne-Edwards and Jules Haime:—*Trochocyathi striati*, with the wall marked with but slightly projecting costæ; and *Trochocyathi armigeri*, with the costæ well developed, crested, spined, or warty. In both of these divisions the shape of the coral is very variable.

Subgenus Tropidocyathus, *Ed. & H.*

The corallum is compressed; the wall is naked, and has a basal expansion. Pali before all the cycles except the last, and they form more or less marked chevrons.

Subgenus Thecocyathus, *Ed. & H.*

The epitheca surrounds the wall and reaches the calicula margin. Corallum with a fixed and broad base, or not fixed.

Subgenus Blanfordia, (genus) *Duncan, Fossil Corals and Alcyonaria of Sind, Pal. Indica*, Sect. xiv. pt. 2, p. 73 (1880).

Corallum cyclolitoid or nummiform in shape, with a flat base. Calice open, axial space shallow, and columella deep and small. Septa numerous, close. Pali before all the septa except those of the last order, small; union of the septa very usual, on both sides of a long primary. Epitheca pellicular, binding the costæ to the discoid base.

Distribution.—Fossil. Eocene: Sind, Asia.

This subgenus includes a remarkable form which commences upon a Nummulite, and the epitheca is very pronounced.

Genus Deltocyathus, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 56 (1857).

Corallum simple, discoid or cup-shaped, free, and without trace of former adhesion; calice subplane; columella fasciculate. Pali well developed, exsert, unequal, before the cycle of septa except the last, arranged in chevrons or deltas. Septa usually exsert except the last cycle. Costæ exceedingly variable in their development, especially the primaries spined or not.

Distribution.—Fossil. Miocene, Pliocene: Europe, Australia?—*Recent.* Caribbean Sea, N., E., and S. Atlantic, Corean Sea, Pacific.

Genus Odontocyathus, *Moseley, Report on Corals 'Challenger' Exped.* p. 148 (1881).

Corallum deep saucer-shaped, with straight sloping sides and a broad flat base, free, but with a scar of former adhesion. Columella fasciculate. Pali in three crowns. The broad base is composed of fused radiating tuberculate spines, which project like the spokes of a wheel all round the base of the wall.

Distribution.—Recent. West Indies.

Genus Leptocyathus, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 50 (1857).

Syn. *Ecmesus*, Phil.

Corallum simple, very short, subdiscoid, free, and without trace of former adhesion. Wall with simple costæ. Calice circular and excavated in the centre. Columella papillary. Septa exsert; and there are denticulate pali before all the septa.

Distribution.—Fossil. Eocene: England, Europe, India?—*Recent.* Caribbean Sea, Azores, Josephine Bank?

Genus Paracyathus, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 52 (1857).

Corallum simple, subturbinate or variable in shape, fixed with a broad base; calice circular or elliptical, open. Columella fasciculate, papillary at the surface, depressed centrally, raised where its outer papillæ are with difficulty distinguished from the pali. These are numerous, and before all the cycles of septa except the last, and the youngest are the largest, often bilobed and projecting, often granular. Septa close, subequal, not very exsert, granulated. Costæ indistinct or fairly developed. Rudimentary epitheca rarely present.

Distribution.—Fossil. Eocene: Europe, England. Miocene, Pliocene: Europe.—*Recent.* Mediterranean, Indian Ocean, Pacific, California (Pearl Islands), Caribbean Sea, N. Atlantic, Josephine Bank.

The genus *Platycyathus*, E. de From. Pal. Franç., Terr. crét., is a discoid *Trochocyathus*, and is therefore absorbed.

Genus Heterocyathus, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 51 (1857).

Corallum simple, the base growing more or less entirely over a small shell upon which it is fixed. Calice as large as the base, subcircular. Columella feebly developed, and composed of slender points. Septa very exsert, thick, and unequal, in four cycles with an incomplete fifth. The septa of the last cycle more developed than the penultimate septa; and they diverge slightly from their neighbours of the higher orders. Pali very slender, denticulate, before all the septa. Wall with distinct equal costæ. No epitheca.

Distribution.—Recent. Philippine, Corean, and East-African seas.

Semper states that there are fossil species (Die natür. Existenz. der Thiere, pt. ii. p. 167, 1880).

The figure given by the authors of the genus indicates that a Sipunculid worm lives in the base of the coral, communicating with the outside by means of small openings. Some forms grow upon dead *Cerithium*-shells which are occupied by a Sipunculid.

Genus Caryophyllia, *Lamarck, Syst. Anim. sans Vertèb.* 1801, p. 370, *amended.*

Corallum simple, with a broad or narrow adherent base, or

bluntly or sharply pointed at the non-adherent base; shape variable, low and broad, cornute, compressed or not, cuneiform, turbinate, subturbinate, elongate, often enlarging near the calice. Calice circular or elliptical, deep or moderately deep. Septa variable in the number of cycles. Pali well developed in one crown. Columella fascicular, twisted, often ending in blunt processes. Costæ distinct or not, crested or spined rarely. Epitheca pellicular or absent or dense. Endotheca very rarely exists.

Distribution.—Fossil. Cretaceous: England, Europe, Southern India. Eocene: Europe and Asia. Miocene, Pliocene: Europe.—*Recent.* Littoral and deep sea, very general.

The essential generic attributes are the simple corallum, fascicular trabeculate columella, and a single crown of pali. Groups of individuals are sometimes found; but the apparent compound corallum is produced by the accidental adhesion of ova to the outside of the corallum of the parent.

Subgenus ACANTHOCYATHUS. Forms with spines on the lateral or larger costæ.

The genus *Bathycyathus*, Ed. & H., is absorbed in *Caryophyllia*.

Blastocyathus, Reuss, is a *Caryophyllia* with accidentally adherent buds.

Dunocyathus, T. Woods, Proc. Linn. Soc. New South Wales, vol. ii. 1878, p. 305:—"Corallum simple, parasitic; base and side immersed in a calcareous organism. One row of pali."

In the determination of the species it is mentioned that the edges of the septa are denticulate, or set with irregular lobes and points. Columella papillary. Diameter 2 millim.

Distribution. Port Jackson.

I think that the description of the solitary specimen of the very small coral can hardly be of sufficient value, and that the genus must be absorbed.

Genus STENOCYATHUS, *Pourtalès, Illustr. Cat. Mus. Comp. Zool. Harvard*, No. iv.; *Deep-Sea Corals*, 1871, p. 9.

Corallum simple, free, very elongated, and of nearly equal dimensions throughout. A single crown of pali. A columella of one or more twisted processes. Epitheca absent.

Distribution.—Recent. Caribbean Sea and Azores.

The genus has some of the features of *Onchotrochus*, but

differs decidedly. The costal tubercles are hollow, and communicate with the visceral cavity. There is some doubt about the epitheca, some specimens having it according to Lindström (see his elaborate morphological description, *op. cit.* p. 19.)

Genus CERATOTROCHUS, *MM. Milne-Edwards & Jules Haime*, *Ann. des Sci. Nat.* 3e sér. t. ix. p. 248 (1848), *amended.*

Syn. *Conotrochus*, Seguenza; *Epitrochus*, E. de Fromentel; *Crispatotrochus*, T. Woods; *Pleurocyathus*, Moseley; *Koilotrochus*, Woods.

The corallum is simple, subpedicellate, and free in the adult state, cornute, long or short, compressed or not; calice circular or elliptical. Septa large and usually exsert, or not appearing above the calicular margin. Columella fasciculate. The costæ are distinct to the base, and are ornamented or spined or plain, or are hidden and are not ornamented. Epitheca present or absent.

Distribution.—Fossil. Eocene, Miocene, Pliocene: Europe.—*Recent*, widely distributed.

This genus is a Smilotrochoid with a columella fasciculate in character; and it would resemble many *Trochocyathi* were their pali removed.

Conotrochus, Seguenza, is merged into *Ceratotrochus* by general consent.

The genus *Epitrochus*, E. de From., Pal. Franç., Zooph. Crét., diagnosed to receive a single specimen of one species, appears to be a young *Ceratotrochus*, and should lapse.

Crispatotrochus, T. Woods, is probably a *Ceratotrochus*.

Koilotrochus, T. Woods, Proc. Linn. Soc. New South Wales, vol. ii. p. 313 (1878):—Corallum simple, free, without trace of adherence; no epitheca. Costæ distinct, simple, prominent. Columella rudimentary, confined to a few papillary projections at the base of the deep and wide calicular fossa. Septa four, slightly exsert.

The calicular fossa is deep and wide.

Locality not given by Rev. T. Woods; but as he refers a form called *Smilotrochus vacuus*, T. Woods, to this genus, probably it is a fossil form. Australian Tertiary.

It appears that this is an aberrant type of *Ceratotrochus*.

Moseley gives the generic name *Pleurocyathus* to a form from

Banda Island, East Indies, 60 fms., which he allies with *Duncania.* The species was described from one specimen only*, which, however, is well preserved. The following is the generic diagnosis :—" Corallum conical, attached by its side; entirely covered by a thin, plicated, coloured, bark-like epitheca, which rises higher than the margin of the calicle. Wall of the calicle very thin, except near the margin, where a zone of stereoplasma is developed, soldering together the outer regions of the septa where they arise from the wall. The lower part of the calicle devoid of stereoplasma or other filling. The columella composed of several flattened pillars."

In the description of the species we learn that the epitheca, in its upper region, is thrown into a series of longitudinal costal folds, which are equally developed and only very slightly prominent. The rounded edges of the primary and secondary septa can just be seen above the level of the margin of the calicle. The wall is very thin. The columella is formed of four flattened pillars, fused together below, but free at their tips, and it projects in the fossa. Height of specimen 8 millim.

Stereoplasma is a name given by Lindström to a substance which connects septa (environing their free edges in some Palæozoic corals), stretches across interseptal loculi irregularly, and sometimes fills up the lower part of the inside of the corallum, constituting a solid mass there. It is to be distinguished from the true endotheca. Its presence as thin, solid, membrane-looking layers is excessively variable in the same species, and it is only of classificatory importance when it fills up the bases of corallites or accumulates near the wall in the interseptal loculi, to diminish the calibre of the coral within, and to add to the strength and thickness of the walls.

The presence of an epitheca is not of generic value; and the longitudinal folds mentioned in the description of the species above are in the position of costæ.

The adhesion by one side is remarkable, and is often the case in *Guynia*, but it is not generic.

Keferstein and E. de Fromentel have both utilized this generic name.

The generic characters of the form are the conical and pedun-

* Report on Corals, Deep-Sea Madreporaria, 'Challenger,' Zool. vol. ii. p. 159 (1881). The provisional title to this beautiful volume does not give the name of the author, H. N. Moseley, F.R.S.

culate shape, the barely exsert numerous septa without pali, and the essential fasciculate columella. It is not separable from *Conotrochus*; and one of the species of this genus, now merged into *Ceratotrochus*, has in some of its individuals stereoplasma joining the septa near the margin, and a bark-like epitheca. The reasons for joining *Conotrochus* and *Ceratotrochus* are evident; and I place Moseley's interesting form, so beautifully figured by him, in *Ceratotrochus*, Ed. & H.

VI. Alliance DISCOCYATHOIDA.

Simple Turbinolidæ, discoid in shape, not increasing much in height with growth. Free or not. With or without pali in one crown. Columella variable; epitheca also.

Genus Discocyathus, Ed. & H.
Genus Brachytrochus, Duncan.
Genus Sabinotrochus, Duncan.
Genus Stephanotrochus, Moseley.
Genus Discotrochus, Ed. & H.
Genus Cyclocyathus, Ed. & H.
Genus Brachycyathus, Ed. & H.
Genus Anthemiphyllia, Pourtalès.
Genus Fungiacyathus, Sars.
Genera absorbed:—Paterocyathus, Duch. & Mich.; Brachytrochus, Reuss.

Whilst admitting the necessity of recognizing discoid species of the genus *Trochocyathus*, there are still several genera which can hardly come within that genus or its alliance, and which contain discoid, low, cup-shaped forms, with and without pali in one row.

The genera *Discocyathus*, *Cyclocyathus*, *Discotrochus*, *Brachycyathus*, *Brachytrochus*, *Sabinotrochus*, and *Stephanotrochus* form an alliance, the Discocyathoid; and their very common facies is not interfered with by the fact that one genus has no columella and another a lamellar one, three others having them essential and fasciculate.

Genus Discocyathus, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3^e sér. t. ix. p. 296 (1848).

The corallum is simple, free, and discoid, with a flat horizontal wall covered with a concentrically folded epitheca. The septa

are broad and exsert; the pali are in one crown; and the columella is essential and lamellar.

Distribution.—Fossil. Inferior Oolite: England and France.

In 1865 Reuss found a small broad-based coral in the Oligocene sands of Nieder Kaufungen, for which he proposed a new genus, *Brachytrochus* ("Zur Fauna des Deutschen Oberoligocäns," Sitzungsb. der math.-naturwiss. Classe der kais. Akad. der Wiss. Wien, 1865, p. 619). The specimens were not of mature forms, and were very small; so that *Brachytrochus Speyeri*, Reuss, is a doubtful species, and the genus must lapse. I have utilized the name, however, as follows:—

Genus Brachytrochus, *Duncan* (*non Reuss*), *Proc. Zool. Soc. Lond.* 1876, p. 436.

The columella is short and shallow, cup-shaped, with a rounded free base. The calice is circular in outline, widely open and deep centrally. The septa are close, moderately exsert, and papillose near the axial space, and slightly dentated on the free margin. There is no columella. The costæ, profusely granular, are moderately developed, and are not seen on the centre of the base. The base is usually deformed and perforated, as it is the home of an annelid.

Distribution.—Recent. Gaspar Straits, 12 fms.

The papillary endings to some of the septa in this genus simulate pali, and the costæ are not very prominent structures.

Genus Sabinotrochus, *Duncan*, *Madrep. of Deep Sea, Trans. Zool. Soc.* vol. viii. pt. v. p. 320, pl. xli. figs. 6–9 (1871).

Corallum simple, flatly turbinate, adherent by a delicate peduncle. Calice open, circular, fossa shallow, margin festooned by the projecting septa. Columella formed by growths from the septal ends. Septa exsert, granular; tertiaries usually unite with the secondaries close to the columella. Costæ unequal, extending mostly to the peduncle, more numerous than the septa.

Distribution.—Recent. Atlantic, 994 fms.

Genus Stephanotrochus, *Moseley*, *Report on Corals, 'Challenger' Expedition*, p. 151 (1881).

Corallum dense and compact in substance, cup-shaped or saucer-shaped, with a trace of early attachment, usually with

well-developed costæ, bearing a succession of small spines with widely open capacious fossa. Septa usually extremely exsert, the exsert quinaries, or quaternaries where these are not present, lying next to the primaries, higher than the tertiaries, or equal to them. Columella short, or little prominent.

Distribution.—Recent. South Atlantic, Azores, Sydney.

This well-marked genus has very decided spines on the costæ in some species, and it has shallow forms and moderately tall ones. It is allied to the two genera *Brachytrochus* and *Sabinotrochus*, but is distinct.

Genus Discotrochus, *MM. Milne-Edwards & Jules Haime, Ann. des. Sci. Nat.* 3e sér. t. ix. p. 251 (1848).

The corallum is simple, free, discoid. The calice is subplane; and the columella is fascicular and papillary. The septa are slightly exsert beyond the calice. The wall is horizontal and costulated.

Distribution.—Fossil. Eocene of Alabama; Miocene of Turin.

Genus Cyclocyathus, *MM. Milne-Edwards & Jules Haime, Brit. Foss. Corals*, p. xiv, 1850 (*Pal. Soc. Lond.*).

The corallum is simple, free, adherent when young, with a horizontal wall and very thin epitheca. The septa are subcrenulate, and the pali are large and before the penultimate cycle. The columella is fasciculate and papillary.

Distribution.—Fossil. Gault: England.

Genus Brachycyathus, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 295 (1848).

The corallum is simple, very short, subpedicellate, and free. The septa are exsert and narrow; and the pali, in one crown, are large, broad, and entire. Calice circular and subplane. Columella fasciculate, and of cylindrical processes, papillary. Costæ indistinct.

Distribution.—Fossil. Neocomian: Hautes Alpes.

The West-Indian Miocene form is not of the genus.

Genus Anthemiphyllia, *Pourtalès, reconsidered, 'Blake' Corals*, 1878–79, p. 112.

Corallum flat or low, free or pedicellate. Columella spongy and coarse, flat above, and fasciculate. Spines of septa trans-

versely flattened. Wall dense. Epitheca well developed, concealing the costæ up to the calicular margin.

Distribution.—Recent. West-Indian Seas.

The late M. de Pourtalès placed this genus near *Discotrochus.*

The remarkable genus *Fungiacyathus* of G. O. Sars comes in here, in spite of its Fungoid appearance.

Genus FUNGIACYATHUS, *Sars, Remarkable Forms of Animal Life from the Great Deeps off the Norwegian Coast*: Christiania, 1872, p. 58, pl. 5.

Corallum simple, free, without trace of former adhesion. Base discoid, nearly circular in outline, thin, nearly horizontal. The septa rise from the base, forming a convex calice, and there is a wide and deep central cavity bounded by the inner ends of the septa. Septa numerous, thin, brittle, often wavy at the free edge, more or less vertical, arched above, tallest externally, lowest near the central depression, converging from the calicular edge inwards, not anastomosing; in six systems, with 6 to 8 orders in each system. Columella formed by septal ends, small. There are no pali. Edge of basal margin with dentations, each one corresponding to a septum. Costæ small, radiating from the centre of the imperforate base. There is no epitheca. In the soft parts, which are of brilliant vermilion colour in the species, numerous small tentacles surround the mouth near the inner edge of the septa.

Distribution.—Recent. Lofoten Islands, 300 fms.

The species of this genus resembles a *Stephanophyllia* or *Bathyactis* in shape, but the septa do not anastomose. There is only a basal wall, and there do not appear to be endotheca or synapticula. The genus is evidently one of the Turbinolidæ, or simple corals without endotheca.

VII. Alliance HAPLOPHYLLOIDA.

Small simple Turbinolidæ, with irregular or more or less quadrate septal arrangement. With or without stereoplasma.

Genus GUYNIA, Duncan.
Genus DUNCANIA, Pourtalès.
Genus HAPLOPHYLLIA, Pourtalès.

These are three genera of corals which belong to the fauna of the recent deep sea, and which have given much trouble to the classificatory zoologist. They present some affinities with the

indefinite group of Palæozoic corals called the Rugosa, and especially with the Cyathaxonidæ. Writing in 1850, MM. Milne-Edwards and Jules Haime (see also Hist. Nat. des Corall. vol. iii. p. 329) state that the little group of Cyathaxonidæ recalls the family Turbinolidæ of the Aporose Madreporaria. The Cyathaxonidæ have, however, a septal fossula and a styliform columella. The genus *Polycœlia*, King, = *Calophyllum*, is also simulated. It is a Permian group. Nevertheless there are many points about the genera *Guynia*, *Duncania*, and *Haplophyllia* which ally them to the Aporose Madreporaria, amongst which they are here included as an Alliance.

Genus Guynia, *Duncan, Madreporaria of Deep Sea, Trans. Zool. Soc.* vol. viii. pt. 5, p. 335 (1873), *amended.*

The corallum is simple, attached, long and narrow. The wall is thick and solid, and has a delicate epitheca and flat costæ. The septa are well developed, unequal, and extend from base to calice. There are four systems of septa; one septum may be longer and larger than the others. The columella is essential, and may be attached to the larger septa. Growth-rings occur. Occasionally the hexameral arrangement of septa occurs, or it may happen in the same corallum with the quadrate.

Distribution.—Recent. Mediterranean and West-Indian seas.

Genus Duncania, *Pourtalès, Zool. Results of Hasslar Exped.* 1874, p. 44*.

Corallum attached, cylindrical, covered with a thick wrinkled epitheca, rising over the border of the calicle. Interseptal chambers filling up solidly from the bottom; septa showing no definite systems; pali sometimes present; a multiple-pillared columella.

Distribution.—Recent. West-Indian seas.

The septa are 18, 20, 21 in number, and the tentacles are about 25 to 30 in number. The length of the species is 20–25 millim., diameter 10–11 millim.

Genus Haplophyllia, *Pourtalès, Bull. Mus. Comp. Zool.* No. 7, and *Illustr. Cat. Harvard Coll.* No. 4; *Deep-Sea Corals*, p. 51.

Corallum simple, fixed by a broad base covered with a thick epithelium. Columella styliform, strong, very thick at the base.

* Lindström, *op. cit.* p. 13.

Interseptal chambers deep, uninterrupted by dissepiments or tabulæ, but filling up solid at the bottom.

In the description of the species, Pourtalès notices that the columella is formed of two smooth conical processes, and that they tend to fill up the coral. There are eight large septa uniting with the columella, and eight smaller reach it at a lower level, and there is a further cycle. 16 tentacles. Height of specimen 1·5 centim., diameter 1·2 centim.

Distribution.—Florida sea, 324 fms.

The next genus to be considered is unique, and its species are usually stated to have each septum divided into three parts. I cannot agree to this view, and believe that the septa are in sets of three. It forms a group.

Genus Dasmia, *MM. Milne-Edwards & Jules Haime*, *Ann. des Sci. Nat.* 3e sér. t. ix. p. 329, pl. 7. fig. 8 (1848), *amended.*

The corallum is simple, free, subturbinate, pedicellate. The costæ are very broad and separated by deep grooves. Septa in groups of three, with projecting granular ornamentation. Each costa corresponds to three septa.

Distribution.—*Fossil.* Neocomian: Europe. Eocene: England and Europe.

Dasmia is represented in the Neocomian of France, and De Fromentel figures *Dasmia Neocomiensis* from Saint-Dizier (Haute Marne). The appearance of the calice is as if there were 12 groups of 3 septa and a septum between each group ('Polyp. de l'étage Néocomien,' pl. 1. figs. 1 & 2, Paris 1857).

The type of the genus is *Dasmia Sowerbyi*, Ed. & H., from the London Clay.

2. Subfam. *Turbinolidæ gemmantes.*

In the genus *Cœnocyathus*, Ed. & H., gemmation occurs from the living parent and from the buds arising from it also. The budding is not like that of the subgenus *Blastotrochus*, or like that which may be seen in *Caryophyllia*, where the ova have accidentally settled upon the parent, for each bud in the species under consideration communicates by its base, or has communicated with the visceral cavity of its parent through the wall. A bush-shaped corallum or colony results; and in the instance of the genus *Cœnocyathus* it attains a considerable size and grows symmetrically.

Genus Cœnocyathus, *MM. Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. ix. p. 299 (1848).

Colony bush-shaped, more or less ramified; corallites long, conico-cylindrical; calices circular, deep. Columella small, and consists of a few twisted processes. Pali in one crown. Wall thick and smooth, or granular or costulate.

Distribution.—Fossil. Oligocene, Miocene, Pliocene: Europe.—*Recent.* Mediterranean.

Genus Gemmulatrochus, *Duncan, Madrep. of Deep Sea, Trans. Zool. Soc.* vol. x. pt. 5, p. 243 (1878), *amended.*

Colony small and bush-shaped. Parent conico-cylindrical, with a broad adherent base. Calice deep; columella rudimentary. Septa stout, not reaching far inwards. Costæ hidden by a well-developed epitheca. Buds ascend in growth, and join others by their epitheca.

Distribution.—Recent. Northern shores of the Mediterranean, littoral.

3. Subfam. *Turbinolidæ reptantes.*

The corallites of the colony grow from an expansion of the basal structures of the parent or assemblage. There is no endotheca, and the septa are plain.

The forms thus differentiated represent the Astrangiaceæ of MM. Milne-Edwards and Jules Haime of their group Astræaceæ.

Genus Polycyathus, *Duncan, Proc. Zool. Soc.* 1876, p. 433, *amended.*

Colony of close or rather distant corallites, cylindro-conical in shape. Calicular margin wavy or angular. Septa irregular, exsert. Pali before the secondaries and tertiaries larger than the ends of the small septa, bilobed or not. Columella deeply seated, small, papillary or spinulose. Costæ subequal, granular. Epitheca well developed.

Distribution.—Recent. South Atlantic, St. Helena.

Subgenus Agelecyathus, (genus) *Duncan, Proc. Zool. Soc.* 1876, p. 434.

There is no epitheca. The costæ are well developed. The colony incrusts, or the stoloniferous expansions are large.

Distribution.—Recent. St. Helena and Persian Gulf.

This subgenus is taken from the genus *Agelecyathus*, nobis.

CHAPTER II.

The family Oculinidæ restricted to its definite limits. The discoveries of Milne-Edwards and J. Haime, Verrill, and H. N. Moseley. The necessary abolition of the Stylasteridæ as a group of Zoantharia Sclerodermata. The soft parts of typical Oculinidæ. Alliances of the family. Descriptions of genera. The family Pocilloporidæ. The necessity for its foundation. The genera *Pocillopora* and *Seriatopora*.

Family OCULINIDÆ, *Ed. & H.* (pars).

The next group of the Madreporaria Aporosa to be considered is one which has been greatly extended by Verrill* and restricted by Milne-Edwards and Jules Haime†, and which requires great modification in consequence of the discoveries of Prof. H. N. Moseley, F.R.S.‡

The Oculinacea of Verrill cover much more ground than the Oculinidæ of Milne-Edwards and Jules Haime, and the family of the Oculinidæ now to be established is very restricted, the Hydrocorallinæ of Moseley having been of course removed. Verrill considers his Oculinacea a suborder; but the group as now restricted can only be of family importance.

Verrill § includes seven families in a suborder—the Oculinacea, some of which can hardly remain thus associated owing to recent advances in morphology. He gives some most valuable information regarding the soft parts of the corals, and very aptly places the genus *Pocillopora*, generally classified with the Tabulata, in his suborder. He also associates the genus *Stylophora* with the suborder.

Milne-Edwards and Jules Haime ‖ described a group of genera which they formed into a family, the Oculinidæ, and it contained three subgroups, one of which now belongs to the Hydrocorallinæ, Moseley, and it omitted some of the groups included subsequently by Verrill.

In the suborder Oculinacea of Verrill the polyps, when expanded, rise above the calice, and may be long and exsert, the

* 'Notes on Radiata,' 1868–71, p. 512.

† Hist. Nat. des Corall. vol. ii. p. 102 (1857).

‡ 'Challenger' Report, 1880, and Quart. Journ. Micr. Sci. no. 88, p. 391 (1883).

§ 'Notes on Radiata,' 1868, p. 512.

‖ Hist. Nat. des Corall. vol. ii. p. 102 (1857), and previously in 'Comptes Rendus,' 1849

mouth protruding. The tentacles are from 10 to 48 and sometimes more in number, elongated, the tips usually, if not always, swollen or capitate, their surface being covered with small wart-like clusters of urticating cells (*op. cit.* p. 512). This structure of the tentacles is much relied upon by Verrill.

For a good representation of a *Caryophyllia*, which would be included by Verrill, drawn from nature by Peach, see 'Monog. Brit. Foss. Corals,' 2nd ser., Pal. Soc. Lond., 1866, Duncan, plate ii. figs. 9–20. The swollen ends of the tentacles are shown, but they are not persistent characters in the genus.

It is clear that the Oculinidæ (*Stylasters* omitted) of Milne-Edwards and Jules Haime are closely allied to the family Turbinolidæ, and, although I cannot associate them in one family, they are neighbours. The family (not suborder) which should now be admitted, must exclude the Stylasteridæ, the Stylinidæ, Astrangidæ, and Caryophyllidæ, which were included by Verrill in his suborder, and should include the Oculinidæ proper of Edwards and Haime and some Stylophoridæ, Ed. & H.

The examination of a large series of specimens of the Oculinidæ of Milne-Edwards and Jules Haime has impressed me with the general truth of their assertion that the visceral chambers fill up by a deposit within, and are intruded upon by the growth of the wall. The growth of the mural structure, which is difficult to distinguish from a solid cœnenchyma, is very characteristic and is often excessive.

II. Family OCULINIDÆ, *Milne-Edwards & Jules Haime* (pars).
Oculinacea, *Verrill* (pars).

Corallites in colonies in the form of branches, espaliers, irregular ramifications on a thick stem, or massive, or incrusting. Increase by gemmation, which is usually lateral and often symmetrical; fissiparity very rare. Interseptal loculi usually open to the base, but dissepiments or tabulæ sometimes occur. Internal space diminishing on account of growth of stereoplasm. Walls of corallites often increasing in thickness, exogenously, with age and becoming a solid mass by union with others. Solid intercalicular or intercorallite cœnenchyma usually present. Septa entire or not at their free edges, sometimes rudimentary. Polyps, when expanded, rising above the wall, or long and exsert, the mouth protruding; the tentacles 10 to 48 or more, elongated, tips usually swollen or capitate.

The very considerable changes in the definition of the family Oculinidæ prevent its being a large one in spite of the additions made by palæontologists and those naturalists who have described the corals of the deep sea.

There are, after revision, 21 genera. Eleven genera disappear and one becomes a subgenus. A genus is relegated to the Astræidæ.

The 21 genera are included in 5 Alliances—the Baryhelioida, the Lophohelioida, the Oculinoida, the Prohelioida, and the Stylophoroida.

I. Alliance BARYHELIOIDA.

Oculinidæ with massive or incrusting colonies. Columella absent and pali also, or a false columella may be present. Septa variable in arrangement. Cœnenchyma well developed between the calices.

Genus Baryhelia, Ed. & H.
Genus Neohelia, H. N. Moseley.
Genus Diblasus, Lonsdale.

Genus Baryhelia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 125 (1857).

Colony massive. Calices slightly projecting or not, small. Septa few, entire, thick and short. Columella and pali absent; a large open fossa existing in the axis of the corallites. Cœnenchyma moderately developed, smooth or finely granulated. Dissepiments rudimentary.

Distribution.—Fossil. Cretaceous: Europe, England.

Genus Neohelia, *Moseley, Report on 'Challenger' Corals,* p. 176, plate x. figs. 7, 7*a* (1881).

Colony with a very abundant and diffuse cœnenchyma incrusting the stems of Gorgonoids with very short branches only. Calices with the septa arranged in five systems, which are often fused together by the cœnenchyma; a deep fossa exists, but no columella. Gemmation irregularly dichotomous.

Distribution.—Recent. Pacific: off Api Island, New Hebrides.

It may be noticed that the surface of the cœnenchyma which separates the calices is marked by very slightly elevated rounded ridges, which traverse it irregularly but with a general longitudinal direction, and are continuous at the margins of the calicles with the short costæ. The primary and secondary septa meet in the fossa.

Genus DIBLASUS, *Lonsdale in Dixon's Geol. Sussex*, 1850, p. 248; *Duncan, Brit. Foss. Corals, Supp., Pal. Soc.*, Part ii. No. 1, 1869, p. 14.

Colony incrusts and is very irregular in shape. The calices are wide apart and project; the columella is formed by the junction of the larger septa, and is parietal and rudimentary. The septa are dentated, crowded and granular laterally. Pali absent. The costæ are granular, equal or subequal, and often extend across the cœnenchyma to neighbouring calices.

Gemmation marginal and intercalicinal.

Distribution.—Fossil. Upper Cretaceous: England.

II. Alliance LOPHOHELIOIDA.

Oculinidæ with dendroid and bunch-shaped colonies. Corallites often coalescing; gemmation alternate. Septal arrangement irregular. Columella absent or rudimentary, tubercular, or spongy, or styliform. Tabulæ or dissepiments present or not. Mural structures thickening with age. Septa entire or subentire, often exsert.

Genus LOPHOHELIA, Ed. & H.
Genus AMPHIHELIA, Ed. & H.
Genus ENALLOHELIA, d'Orb.
Genus EUHELIA, Ed. & H.
Genus ACROHELIA Ed. & H.
Genus ASTROHELIA, Ed. & H.
Genus DENDROHELIA, Etallon.

Genus LOPHOHELIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxix. p. 69 (1849); *P. Martin Duncan, Trans. Zool. Soc. Lond.* vol. viii. pt. 5, p. 330 (1873).

The colony is dendroid, and its gemmation is subterminal and irregularly alternate; the granulated wall is thick and increases in thickness with age. The calices are very deep; the septa are well developed, exsert, entire, and unite more or less at the bottom of the calicular fossa. Arrangement of septal orders irregular. Columella absent or false; costæ near the calicular margin. Dissepiments may exist, and often well-developed tabulæ, which close in the calice inferiorly. Internal cavity not filling up much with age.

Distribution.—Fossil. Miocene, Pliocene: Europe.—*Recent.* Atlantic, N. & S.; Caribbean Sea; Mediterranean; East Indies; Philippines.

This genus has given much trouble in its classification, and some time since I was disposed to place it in the Astræidæ; but its proper position appears to be here.

Genus Amphihelia, *Milne-Edwards & Jules Haime*, 1849 (pars); *P. Martin Duncan, Trans. Zool. Soc. Lond.* vol. viii. pt. 5, p. 326 (1873), *amended.*

Syn. *Diplohelia*, Ed. & H.

The colony is bush-shaped, and the gemmation is alternate, marginal, and often double. The wall, with or without cœnenchyma, increases in thickness at the lower part of the colony, and often includes formerly free corallites. Corallites free, immersed or coalescent. Columella exists. The septa are entire or subentire, in six systems; but there are few cycles. Costal striæ very variable in amount and direction. Ornamentation of the wall granular or absent. Internal cavities do not fill up; dissepiments absent.

Distribution.—Fossil. Eocene, Miocene, Pliocene: Europe. Cainozoic: Australia.—*Recent.* Atlantic, Mediterranean, Caribbean, Australian seas; Formosa.

This genus absorbs *Diplohelia*, Milne-Edwards & Jules Haime, 1850.

The genus *Enallhelia*, d'Orbigny, 1848, was insufficiently diagnosed as follows:—"Ce sont des Oculines, dont des calices saillants sont latéraux et alternes de chaque côté des branches. Calices pourvus de côtés en dehors." This description is not distinctive. MM. Milne-Edwards and Jules Haime added to the description, and slightly altered the name; and M. de Fromentel has made some very important additions to the characters of some species. The presence of paliform lobes on some septa, and the subentire condition of the septa were asserted by M. de Fromentel, but they are doubtful points. The existence of hexameral, octameral, and decameral types in the genus is extremely interesting.

Genus Enallohelia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 123 (1857), *amended.*

Colony dendroid or bushy, or low compressed, and branches uniting; gemmation alternate and distichous. Calices small and shallow, often oblique. Columella styliform, but often small and even rudimentary. Septa few, slightly exsert, subentire, some swollen at inner end, arranged in systems of six or eight or ten. Costæ visible near the calice; wall-cœnenchyma considerably developed.

Distribution.—Fossil. Oolitic: Europe, England? Cretaceous: Europe.

Genus EUHELIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 124 (1857), *amended.*

Colony dendroid; gemmation distichous and at right angles with the margins of the parent calice. Corallites subturbinate. Septa entire where free. Columella rudimentary. Costæ subequal and project near the calice. Surface granular. Often one bud aborts.

Distribution.—Fossil. Jurassic: Europe.

Genus ACROHELIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 115 (1857).

Colony dendroid. Calices with extremely exsert septa, entire, lanceolate in shape, and they unite by their inner margins at the bottom of the calicular fossa. Columella and pali absent. Costæ in the neighbourhood of the calices only. Gemmation regularly spiral in direction.

Distribution.—Recent. Fiji.

Genus ASTROHELIA, *Milne-Edwards & Jules Haime, Comptes Rendus de l'Acad. des Sci.* t. xxix. p. 68 (1849), *amended.*

Colony subdendroid, with more or less coalescing branches or incrusting. Calices unequal, not projecting much, moderately deep. Columella rudimentary, very small, parietal. No pali. Septa dentated. Costæ extending down but slightly. Gemmation irregular. Cœnenchyma granular, thin. Bases of corallites not increasing much in density during growth.

Distribution.—Fossil. Miocene: Europe, North America.

There is no doubt that the genus *Dendrohelia* of Etallon ('Lethæa Bruntrutana,' p. 358, 1860) is unsatisfactory. Milne-Edwards and Jules Haime considered the typical species of Etallon to be a doubtful member of the genus *Stylina.* The balance of evidence is in favour of the species *Dendrohelia coalescens*, Etall., being one of the Oculinidæ. But Etallon is very much in error when he compares the genus with the modern *Acrohelia*, to which it has only a remote family likeness.

Etallon considers the genus *Dendrohelia* to include some species of *Helicœnia*=*Stylina*; but it must be remembered that the species of the genera just noticed are represented by much-worn or considerably altered specimens.

Genus DENDROHELIA, *Etallon, Lethæa Bruntrutana*, 1864, p. 358, pl. l. fig. 4.

Colony mammillated or branched, coalescing. Cœnenchyma well developed and compact, especially on the parent stem. Calices irregularly placed, sometimes in a subspiral manner, costulate near the margin. Stem granular. Columella styliform. Septa unequal, entire, or non-exsert. Gemmation irregular.

Distribution.—Fossil. Oolite of Europe.

III. Alliance OCULINOIDA.

Oculinidæ with arborescent or tufted, alternately, oppositely, or dichotomously gemmating colonies. Gemmation rarely from one side only. Septa entire, subentire, or spinulose where free. Pali before one or more sets of septa. Columella various. Fissiparity very rare.

Genus OCULINA, Ed. & H.
Subgenus AGATHELIA, Reuss.
Genus CYATHOHELIA, Ed. & H.
Genus SYNHELIA, Ed. & H.
Genus TRYMOHELIA, Ed. & H.
Genus SCLEROHELIA, Ed. & H.
Genus BATHELIA, H. N. Moseley.
Genus HAPLOHELIA, Reuss.

Genus OCULINA, *Milne-Edwards & Jules Haime, Comptes Rend. de l'Acad. des Sci.* t. xxix. p. 68 (1849), *amended.*

Colony arborescent or in tufts. Corallites arranged more or less distinctly in ascending spiral series, or scattered irregularly, prominent or sunken, often arising from an incrusting base. Cœnenchyma solid and smooth or finely papillose. Calices circular, oval, prominent or depressed. The columella either well developed and papillary at the surface, compact at the base, or rudimentary. The septa are well developed, entire or slightly spinulose where free, some exsert. Pali exist before all the septa except those of the last cycle. Costæ as striations, or decided projections extending a short distance from the calicular margin. In rapidly growing forms there is no cœnenchyma independent of the buds. Endotheca may exist.

There are two sections of the genus. In the first, which contains the majority of the recent forms, the growth is by gemmation; and in the second, which contains recent and fossil forms, there is also fissiparous division.

Distribution.—Fossil. Eocene: Europe, Asia. Miocene:

Europe and America.—*Recent.* Indian Ocean, Pacific (?), Florida and Caribbean seas, Bermudas.

The Rev. Tennison Woods founded a new genus, *Platyhelia*, for Oculinacea with the usual compact dermic tissue and with pali, but spreading and incrusting instead of growing in a ramose tuft (Palæont. New Zealand, Corals and Bryozoa, p. 15, 1880).

There is one specimen of a species only, and it is so probable that further research will relegate the form to the genus *Oculina* that it is recorded here but not formally placed. The bases of some pali-bearing Oculinacea spread out and incrust before the upward growth occurs.

Subgenus AGATHELIA, (genus) *Reuss*, "*Beiträge zur Char. der Kreid. in den Ostalpen*," 1854, *Denks. der Kais. Akad. der Wiss. Wien*, p. 82.

Colony covering some space, gibbous and lamellar, with the corallites widely and unsymmetrically scattered. Cœnenchyma compact and granular at the surface and noncostulate. Calices conical, projecting, deep. Septa thin, unequal, denticulate, barely exsert. Columella of very delicate trabeculæ (Stäbchen). Pali before the first two cycles out of the three.

Distribution.—Fossil. Cretaceous: Europe.

Genus CYATHOHELIA, *Milne-Edwards & Jules Haime, Comptes Rendus de l'Acad. des Sci.* t. xxix. p. 68 (1849), *amended.*

Colony dendroid, like a dichotomous cyme. Corallites free to a considerable extent except on the side, whence they bud, subturbinate or subcylindrical. Parent corallites compressed between the bases of the buds. Calices elliptical, shallow, compressed laterally. Columella well developed, papillose, elongate rather. Septa subentire, numerous, exsert. Pali large, distinct, higher than the columella, in two crowns, the outer in front of the tertiaries, absent before the last cycle of septa. Costæ visible near the calicular margins only. Surface of the greatly thickened walls granular. Gemmation opposite.

Distribution.—Recent. Japanese and Corean seas, Moluccas, to 825 fms.

Genus SYNHELIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vii. p. 113 (1857), *amended.*

Colony dendroid, gibbous on the surface. Calices irregular

on the stem, more or less spirally placed on the branchlets, superficial and circular. Columella solid, with a solitary styliform tubercle. Septa crenulated and stout; some of the smaller septa unite, and before them are pali or paliform lobes. Costæ well marked, radiating and often uniting with those of other calices.

Distribution.—Fossil. Cretaceous: Europe, England.

Genus TRYMOHELIA, *Milne-Edwards & Jules Haime, Comptes Rend. de l'Acad. des Sci.* t. xxix. p. 68 (1849).

Colony dendroid. Calices arranged in more or less spiral lines, shallow, and with a low margin. There is no columella. Septa thick externally, subentire at the free edge. Pali before the primaries and secondaries, and these last the largest; they unite laterally to form a vertical tube with thick walls, which fills up below. Costæ equal and in striations, which are directed towards the base of the colony. Cœnenchyma greatly developed, granular.

Distribution.—Fossil. Miocene: Europe. *Recent.* Pacific.

Genus SCLEROHELIA, *Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3^e sér. t. xiii. p. 75 (1850); *P. Martin Duncan, Proc. Zool. Soc. Lond.* 1876, p. 437.

Colony dendroid, branches often coalescing, incrusting often at first. Calices circular, immersed or slightly prominent on the stem, or projecting and gemmating, situated irregularly on the numerous terminal branchlets. Cœnenchyma well developed on the stems, glistening or very minutely granular, marked but little by costal striæ. Columella solid in three or many lobes, often consolidated together. Septa well developed, subentire, laterally granular, unequal. Pali moderately developed and placed before the secondary septa, often irregular. Dissepiments occur.

Distribution.—Recent. South Atlantic, St. Helena.

Genus BATHELIA, *Moseley, Report on 'Challenger' Corals,* p. 177, pl. viii. figs. 1–6 (1881).

Colony arborescent; calices disposed alternately in nearly straight rows on either sides of the several branches, with very prominent margins. Cœnenchyma white, compact, and dense, with its surface covered entirely by curved striæ continuous with

the costæ. Calices deep and widely open, with four cycles of septa and a single crown of pali. Columella large, composed of numerous trabeculæ. Gemmation alternate.

Distribution.—Recent. Off Rio de la Plata, 600 fms.

Genus HAPLOHELIA, *Reuss, "Anth. und Bryoz. des Mainzer Tertiär.," Sitzungsb. der Kais. Akad. der Wiss. Wien*, 1865, p. 202.

Colony branching. Calices on one side of the stem. Columella small, papillary. Septa in three cycles, and papillose pali before the primaries and secondaries. Costæ as long lines of long granules with intermediate depressions running along the whole branch.

Distribution.—Fossil. Miocene: Europe.

IV. Alliance PROHELIOIDA.

Oculinidæ with branched espalier-like colonies. Corallites projecting and twisted. Columella styliform. No pali. Septa entire. Cœnenchyma well developed.

Genus PROHELIA, E. de Fromentel.
Genus absorbed:—STYLANGIA.

Genus PROHELIA, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 177 (1861).

Syn. *Stylangia*, E. de From.

Colony branched, espalier-like. Calices projecting, placed in two parallel series along the sides of each branch, and all are directed forwards; they spring from the posterior part of the branches and twist to the right or left to come to the front. Columella styliform. Septa entire. Costæ rudimentary. Cœnenchyma very developed, compact and strongly granulated.

Distribution.—Fossil. Jurassic and Cretaceous: Europe.

This genus absorbs, according to M. de Fromentel, his genus *Stylangia*.

V. Alliance STYLOPHOROIDA.

Oculinidæ with arborescent, palmate, or incrusting colonies. Septa few, 10 or 12 or 24, unequal. Columella styliform. Cœnenchyma subcompact, compact, or cellular, granular. Costæ developed, short or absent. Dissepiments present. Gemmation irregular.

Genus STYLOPHORA, Ed. & H.
Genus STYLOHELIA, E. de From.
Genus MADRACIS, Ed. & H.

The genera PSAMMOHELIA, E. de From., and PHYLLOPORA, Tennison Woods, are absorbed in *Stylophora*; AXOHELIA, Ed. & H., PENTALOPHORA, Kent, REUSSIA, Duch. et Mich., in *Madracis*; AREACIS, Ed. & H., is removed to the Astræidæ.

Genus STYLOPHORA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 133 (1857).

Syn. *Psammohelia*, E. de From.; *Phyllopora*, T. Woods.

Colony arborescent, or palmate, or incrusting. The calices are rather deep, and present a styliform columella. The septa are unequal, six being well developed and six rudimentary. Cœnenchyma between the corallites subcompact and granulated, and often ridged. The costæ are rudimentary. Dissepimental endotheca present, and the internal cavity often obliterated. Gemmation irregular and lateral.

Distribution.—Fossil. Eocene: Europe, West Indies, Sind in Asia. Miocene and Pliocene: Europe. Miocene: Sind in Asia.—*Recent.* Red Sea, Indian Ocean, Cape of Good Hope, Chinese seas, Australian seas?

Genus STYLOHELIA, *E. de Fromentel, Introd. à l'étude des Polyp. Foss.* 1858–60, p. 180.

Colony massive or dendroid. Calices very projecting as truncated cones, strongly costulate near the calices, but granular over the rest of the cœnenchyma, which is foliated and more or less dense. Columella strong and styliform. The larger septa unite with the columella by means of horizontal trabeculæ regularly placed. Septa in three cycles, the last rudimentary.

Distribution.—Fossil. Oolite: Europe.

Genus MADRACIS, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 139 (1857), *amended.*

Syn. *Axohelia*, Ed. & H.

Colony arborescent or incrusting more or less. Calices small, shallow, with a sharp styliform, sometimes compressed columella, and ten or twelve equal, exsert, subentire septa. Gemmation spiral more or less, or irregular. Cœnenchyma nearly compact

and strongly echinulate or cellular, often with an intercalicular ridge. Costæ absent. Internal cavities filling up more or less.

Distribution.—Recent. Madeira, Florida, Caribbean sea, Brazils, Isle de Bourbon, Indian Ocean, (Adriatic ?).

This genus absorbs *Axohelia*, Milne-Edwards & Jules Haime, 1849, which was placed by those authors in the Stylasteraceæ (Hist. Nat. des Corall. vol. ii. p. 126); and as the other Stylasteraceæ have been shown by Moseley to be Hydrocorallinæ, the subfamily disappears entirely from the Zoantharia Sclerodermata.

Milne-Edwards and Jules Haime introduced their genus *Areacis* into the group which associated *Stylophora* and *Madracis*; but its species must be relegated to the Astræidæ with a cellular cœnenchyma and ill-developed visceral tabulæ.

In this arrangement of the Oculinidæ the following genera are absorbed or are not considered, in consequence of unsatisfactory definition or evident synonymy:—

DIPLOHELIA, Ed. & H.
STYLANGIA, E. de From.
PSAMMOHELIA, E. de From.
AXOHELIA, Ed. & H.
PHYLLOPORA, T. Woods.
TIARADENDRON, Quenst.
PLACOHELIA, E. de From.
PHYLLOHELIA, E. de From.
PLATYHELIA, T. Woods.
PENTALOPHORA, Kent.
REUSSIA, Duch. et Mich.

The genus *Aagthelia*, Reuss, becomes a subgenus of *Oculina*. The genus *Areacis*, Ed. & H., is removed to the Astræidæ.

III. Family POCILLOPORIDÆ.

Colonial Aporose Madreporaria with tabulæ, septa small and rudimentary. Columella well or ill developed. Corallites filling up with steroplasma. Intercorallite structure cœnenchymal and solid. Animal with disk, tentacles, and a single pair of long mesenterial filaments.

Verrill stated, in his 'Notes on Radiata,' p. 523, that *Pocillopora*, although a tabulate coral, must enter the section in which he placed the Oculinidæ. He satisfied himself of the correctness of Mr. Bradley's observations that *Pocillopora* had twelve tentacles, six being upright and six held horizontally, and that it was not a Hydroid. The arrangement and form of the tentacles resemble those of the Perforate coral *Porites*, but the tissues are solid.

Moseley (Quart. Journ. Micr. Sci. lxxxviii. p. 391, "Notes on the Structure of *Seriatopora*," &c.) states that *Seriatopora* is Madreporarian. The polyps bear twelve short tentacles with rounded knobs in two series. The cavities of the polyps are in communication by means of a canal-system forming a network, which traverses the entire area at the surface between the polyps. The polyps of *Seriatopora* and *Pocillopora* possess only a single pair of long mesenterial filaments, and these belong to the central mesenteries of the lateral chambers. Both of the genera differ from other Madreporaria in not having their mesenteries arranged in pairs.

Genus Pocillopora, Lamarck & Verrill.
Genus Seriatopora, Lamarck.

Genus Pocillopora, *Lamarck* (pars); *Verrill, Notes on Radiata*, p. 519 (1870).

Colony of clusters of branches, or lobes, or fronds of various dimensions, which arise from a more or less compact incrusting base. Branches often with rudimentary branchlets or verrucose. Corallites crowded terminally, angular, and closely united by their walls; on the sides of branches they are more or less separated by compact cœnenchyma which is sharply spinulose or granular. Calices small, may be deep or shallow, circular or angular, often filled, below the surface, by a solid deposit. The corallites are crossed by tabulæ. Septa narrow, often rudimentary, especially in the crowded calices at the ends of branches, in others longer, usually twelve in number, six larger than the others. Columella when present small, solid, little prominent on the upper tabulæ. Tabulæ often incomplete in middle. Increase by gemmation. Fissiparity very rare. Polyps with 12 tentacles, and a single pair of long mesenterial filaments.

Distribution.—Fossil. Miocene: West Indies.—*Recent.* Pacific, Indian Ocean, Red Sea.

Genus Seriatopora, *Lamarck, Hist. Anim. sans Vertèb.* t. ii. p. 282 (1816).

Colony arborescent. Cœnenchyma compact and abundant, finely echinulate. Calices placed in ascending series. Septa rudimentary and barely visible. Columella large, compact.

Internal cavities obliterating almost completely with the growth of the base of the columella and walls. Traces of tabulæ.

Distribution.—Recent. Red Sea, Indian Ocean, Pacific.

If *Seriatopora* is admitted into the Oculinidæ with *Pocillopora* the question occurs, what is to be done with *Dendropora*, Michelin, *Rhabdopora*, Milne-Edwards & Jules Haime, and *Trachypora*. They are associated with *Seriatopora* by Milne-Edwards and Jules Haime in a family of Tabulata; and before I had read Nicholson's excellent analysis of the genera (Nicholson, 'Tabulate Corals,' p. 105, 1879), I agreed with the great French zoophytologists, but now I see the necessity of placing those genera amongst the Favositidæ.

CHAPTER III.

Family Astræidæ, definition. The necessity for the union of the old subfamilies Eusmilinæ and Astræinæ. The condition of the upper edge of the septa not of physiological or subfamily importance. Subfamilies determined by the method of growth. List of the seven subfamilies:—I. Subfamily ASTRÆIDÆ SIMPLICES: the Alliances and Tribes; description of the Genera, lists.—II. Subfamily ASTRÆIDÆ REPTANTES: Alliances, Genera, lists.—III. Subfamily ASTRÆIDÆ GEMMANTES: definition, Alliances, Genera, list. IV. Subfamily ASTRÆIDÆ CÆSPITOSÆ: Alliances, Genera.—V. Subfamily ASTRÆIDÆ CONFLUENTES: Alliances, Genera.—VI. Subfamily ASTRÆIDÆ AGGLOMERATÆ FISSIPARANTES: Alliances, Genera.—VII. Subfamily ASTRÆIDÆ AGGLOMERATÆ GEMMANTES: Alliances, Genera, Lists.

Family ASTRÆIDÆ, *Dana* (pars), 1846; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 142 (1857).

Simple or colonial Aporose Madreporaria, multiplying by ova, rarely by deciduous buds; increasing in bulk by gemmation and by fissiparous division and serial growth. Interseptal loculi containing dissepimental endotheca, rarely tabulæ. Septa smooth or entire at the free edge, or dentate, ragged or spinulose. Soft parts closely resembling those of the Turbinolidæ: the long serial calices have several mouths in the limited disk, which is surrounded by tentacles. Tentacles contract and are hidden by the edge of the disk. A mesentery projects downwards in each interseptal loculus as far as the upper dessepiment, and sustains the ovarial organ. Corallites may unite by their walls, or costæ, or exotheca, or a vesicular peritheca may exist, but true intermural solid cœnenchyma is rarely seen.

The subfamily Eusmilinæ and the subfamily Astræinæ of Dana

and Edwards and Haime are united, and the whole Astræidæ are subdivided into seven subfamilies.

Although it is proposed to abolish the classificatory distinction between the Astræidæ with entire and with dentated or ragged septal edges, it is necessary to keep in view the method of growth and increase of the forms. Milne-Edwards and Jules Haime founded their classification of both of the groups, now united, upon the principles of their gemmation and growth. Thus the Eusmilinæ, Ed. & H., or the Astræidæ with entire septa, were classified as Simple, Cæspitose, Confluent, and Agglomerate; and the Astræidæ with dentate septa, the Lithophylliaceæ, Ed. & H., were grouped almost after the same manner into Simple, Cæspitose, Meandroid, Fissiparous, and to these was added the agèle of the budding Astræaceæ. These divisions or "agèles" are fairly natural, and it is only rarely that some hard and fast lines of distinction oppose the truth. Fissiparity is the rule amongst the cæspitose and confluent Eusmilinæ, and amongst the cæspitose and meandroid Lithophylliaceæ; but it is accompanied by more budding than has been hitherto admitted. Moreover the long serial calices of the confluent and meandroid forms seem to develop by simple growth from the calicular ends quite as much as by an indefinite fissiparity. The great break was between the Cæspitose and Meandroid Lithophylliaceæ with dentate and ragged septa. Thus the genera *Mussa*, Oken, and *Symphyllia*, Ed. & H., are very closely allied, and at one stage they must belong to the Meandroid group; but the early life of the *Mussæ* is often passed in a cæspitose condition of growth. It is necessary to place these genera, the one at the close of the Cæspitose and the other at the commencement of the Meandroid group.

In the present classification, the Eusmilinæ, Lithophylliaceæ, and Astræaceæ, being absorbed in the family Astræidæ, the agèles of Milne-Edwards and Jules Haime become subfamilies, and their sections also. The simple forms of both groups are united in a subfamily *Astræidæ simplices*. The cæspitose genera of the Lithophylliacæ and Eusmilinæ become cæspitose Astræidæ; and the meandroid Lithophylliaceæ and the confluent Eusmilinæ become confluent Astræidæ. The Astræaceæ or massive budding group become *Astræidæ agglomeratæ gemmantes*.

It is evident that the genera which increase by stoloniferous gemmation must form a subfamily, and that the dendroid forms

with simple gemmation, their close allies, must belong to another. Hence the three original great groups of Edwards and Haime form one family, the Astræidæ, and it is divided into seven Subfamilies.

The Subfamilies are divided into Alliances, the genera of which have their species divided into tribes which are distinguished by the presence or absence of entire septa.

IV. Family ASTRÆIDÆ.

Subfamily 1. *Astræidæ simplices.*
" 2. " *reptantes.*
" 3. " *gemmantes.*
" 4. " *cæspitosæ.*
" 5. " *confluentes.*
" 6. " *agglomeratæ fissiparantes.*
" 7. " *agglomeratæ gemmantes.*

1. Subfamily *Astræidæ simplices.*

Simple solitary Astræidæ with entire or incised, dentate or spinulose septal edges. Propagation by ova and rarely by deciduous buds. Pali may or may not exist. Endotheca always present, but variable in amount.

Alliance I. TROCHOSMILIOIDA.
II. PLACOSMILIOIDA.
III. LITHOPHYLLIOIDA.
IV. ASTEROSMILIOIDA.
Group V. Genus AXOSMILIA.

Each of these Alliances is divided into two tribes, one of which receives genera with entire septa, and the other contains genera with dentate septa.

There are six genera which become subgenera, and fifteen genera are absorbed.

I. Alliance TROCHOSMILIOIDA.

Simple corals with entire or dentated, incised, ragged, or spined septa. Endotheca. Columella absent or rudimentary. Costæ distinct. With or without epitheca. Pali absent.

Tribe I. With entire septa.
" II. With dentate, incised, ragged, or spined septa.

I. Genus TROCHOSMILIA, Ed. & H.
Subgenus EPISMILIA, E. de From.
Subgenus CŒLOSMILIA, Ed. & H.
Genus DIPLOCTENIUM, Goldfuss.

II. Genus MONTLIVALTIA, Lamouroux.
Subgenus LEPTOMUSSA, d'Achiardi.
Subgenus OPPELISMILIA, Duncan.
Subgenus CERATOPHYLLIA, v. Fritsch.
Genus FEDDENIA, Duncan.

Genera absorbed:—
ELLIPSOSMILIA, d'Orb.; PSAMMOSMILIA, E. de From.
Genera becoming subgenera:—
Epismilia, Cœlosmilia, Leptomussa, Oppelismilia, and *Ceratophyllia.*

Tribe I.

Genus TROCHOSMILIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 467 (1848).

Syn. *Ellipsosmilia,* d'Orb.

The corallum is simple, and either subpedicellate or fixed by a broad base, compressed or not, often deformed. Calice circular, elliptical, elongate, or deformed. Columella absent. Septa entire, numerous, exsert or not, often lobed. Costæ distinct. Endotheca present. Epitheca absent or rudimentary.

Distribution.—Fossil. Jurassic, Cretaceous: Europe, North America, Asia. Eocene: Europe, Asia. Miocene: Europe.

D'Orbigny founded the genus *Ellipsosmilia,* which he described as *Trochosmilia* with an oval calice and slightly enlarged base. The septa do not meet at the centre, but leave a hollow space there transverse to the columella (Eléments Zoologiques, p. 160; Cours élémentaire de Paléontologie &c., 1851; genus founded in 1848).

Milne-Edwards and Jules Haime decided not to admit the genus, and referred the species to other genera, such as *Trochosmilia* and *Montlivaltia.* Etallon resuscitated *Ellipsosmilia* in 'Etudes Paléont. sur le Haut Jura;' and M. de Fromentel pointed out in his 'Introd. à l'Etude des polyps. foss.' the error into which Etallon had fallen.

There appeared to be some reasons for the establishment of a genus which should absorb *Ellipsosmilia* and certain *Montlivaltiæ* which were supposed to have entire septa. But the influence of fossilization and of weathering on *Montlivaltiæ,* in wearing down their denticulate septal edges, does not seem to have entered the thoughts of any palæontologists who have described species of this genus, *Epismilia.* It is remarkable that whilst *Montlivaltia* has survived to the present day, *Epismilia* did not enter the

later Tertiary faunas. I do not consider *Epismilia* otherwise than a subgenus.

Subgenus Epismilia, (genus) *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 104 (1861).

Syn. *Psammosmilia*, E. de From.

Corallum free or adherent, trochoid or subcylindrical. Septa large and entire. No columella; columellary space elongate. An epitheca, membraniform and complete, forming transverse ridges. Endotheca abundant.

Distribution.—Fossil. Jurassic: Europe. Cretaceous: India and Europe. Eocene: Europe.

It is to be noticed that in the typical species, *Epismilia Haimei*, E. de From., the septa are exceedingly numerous; that the septa of the 1st, 2nd, and 3rd cycles have the upper free edge sharp and entire, their inner edge being slightly swollen and undulating; and that the septa of the other orders have regular dentations on their inner edge. The species have large individuals as a rule. The only distinction between this genus and *Trochosmilia*, Ed. & H., 1848, is that this last has the wall covered with costæ, and a rudimentary epitheca in some instances. This last structure is not mentioned in the diagnosis of Milne-Edwards and Jules Haime, but it is as evident as it is in some Caryophylliæ.

As it is of great importance that the genera should be well defined, it is impossible to retain both of these; and hence I place *Trochosmilia*, Ed. & H., 1848, as the genus which contains, amongst others, certain species with a well-developed epitheca, belonging to a subgenus, *Epismilia.*

Psammosmilia, E. de From. Pal. Franç., Terr. crét. 1863, differs from *Epismilia* in having a broad base, which is not generic. It must be absorbed.

The genus *Cœlosmilia*, Milne-Edwards and Jules Haime, has a considerable number of species with a well-defined facies, but its alliance with *Trochosmilia* is exceedingly close. Formerly I had absorbed *Cœlosmilia* in *Trochosmilia*, but now I propose to consider it as a subgenus. The main distinction between the two types only relates to the amount of endotheca.

Subgenus Cœlosmilia, (genus) *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 175 (1857).

The corallum is simple, fixed or pedicellate, subturbinate,

slightly or not compressed. Columella absent. Septa large and exsert. Costæ straight, simple. Wall naked. Endotheca scanty.

Distribution.—Fossil. Cretaceous: England, Europe. Eocene: Europe.

Cœlosmilia fecunda, Pourtalès, from the Florida seas, was placed by him in the genus *Parasmilia* ('Corals of the Blake Expedition,' p. 109).

The genus *Brevismilia*, Bölsche, was founded on a figure given by Roemer of his *Lithodendron nanum*. It can hardly stand.

Genus DIPLOCTENIUM, *Goldfuss, Petrefacta Germaniæ*, t. i. p. 50 (1826); *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 166 (1857).

Corallum simple, exceedingly compressed, subflabelliform, with the flanks directed downwards; free, pedicellate. Wall naked, with numerous close subequal costæ, which divide and subdivide. The very long calice has its axes very unequal; it is narrow and deep. Columella absent. Septa very numerous, slightly exsert, nearly equal. Endotheca well developed.

Distribution.—Fossil. Cretaceous: Europe.

Tribe II.

Genus MONTLIVALTIA, *Lamouroux, Exp. méth. des genres des polyp.* p. 79 (1821); *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 296 (1857).

The corallum is simple, and either fixed by a broad base or free, and in this last case pedicellate, or with a scar of former adhesion. Variable in shape, some being turbinate, subturbinate, cylindro-conical, or discoid. Wall feebly developed, covered with a well-developed epitheca. Calice circular, subcircular, elliptical, deep or shallow, or convex in some discoid forms. No columella. Septa stout and numerous, dentate or spiny, or nodulose or lobed, often exsert. Endotheca abundant.

Distribution.—Fossil. Trias to Eocene: Europe. Jurassic, Cretaceous, Eocene, Miocene: Asia. Jurassic: England.—*Recent.* Caribbean Sea.

Montlivaltia discus, Wood (Australia, recent), is not a species of the genus. It has clearly synapticula, and is one of the Fungidæ.

Subgenera:—*Leptomussa*; *Oppelismilia*; *Ceratophyllia*.

Subgenus LEPTOMUSSA, *d'Achiardi, Monogr. der Vicentenischen Korallen.*

(Quoted by A. E. Reuss, Pal. stud. über die ält. Tertiärsch. der Alpen, II. Abtheil., Wien, 1869, p. 24.)

Corallum variable in shape, often cylindro-conical, compressed, with large costæ, which are crested and spined. Epitheca scarcely developed. Septa double, very numerous and mostly equal. Endotheca abundant. There is no columella.

Distribution.—Fossil. Eocene: Europe, Asia.

Subgenus OPPELISMILIA, *Duncan, Brit. Foss. Corals, Supp.* pt. iv. no. 1, p. 39 (1867).

Corallum simple, attached, conical. Calice shallow. Columella absent. Septa numerous, close and unequal. The epitheca is well marked, and reaches the calicular margin. Gemmation occurs within the calice, and the bud has an epitheca.

Distribution.—Fossil. Lias: Ireland. Oolite: England, Europe.

Milaschewitsch has described some of these forms as *Montlivaltiæ*, and considers the gemmation only a rejuvenescence, which it is not. The coral he describes as *Montlivaltia turbata* shows two buds from the calice, and is one of the subgenus.

Subgenus CERATOPHYLLIA, (genus) *K. v. Fritsch*, "*Foss. Korall. d. Numm. v. Borneo*," *Palæontographica*, Supp. Band iii. 1878.

This is a *Montlivaltia* with paliform lobes.

Distribution.—Fossil. Eocene: Borneo.

Genus FEDDENIA, *Duncan, Fossil Corals and Alcyonaria of Sind, Pal. Indica*, ser. xiv. pt. 2, p. 36 (1880).

The corallum is simple, free, with an irregularly-shaped base, which has enclosed a foreign body. Calice usually constricted, crowded with uniting dentate septa, ending in paliform lobes. Columella absent. Costæ not directed to the sharp end of the base, but passing straightly and parallel down the sides of the wall, sometimes keeled. Epitheca, when it exists, variable, and often in broken mosaic or granular. Endotheca scanty. Granules of the septa unite here and there, forming false synapticula.

Distribution.—Fossil. Ranikot group, Eocene: Sind.

II. Alliance PLACOSMILIOIDA.

Simple corals, with entire or denticulate septa. A lamellar columella. Endotheca in variable quantity. Epitheca present or absent. Without pali.

Tribe I. With entire septa.
" II. With denticulate septa.

I. Genus PLACOSMILIA, Ed. & H.
Genus LOPHOSMILIA, Ed. & H.
Subgenus PLESIOSMILIA, Milasch.
Genus PLEUROSMILIA, E. de From.
Genus PEPLOSMILIA, Ed. & H.
Genus BLASTOSMILIA, Etallon.

II. Genus SPENOPHYLLIA, Moseley.

Genera absorbed:—

PHYLLOSMILIA, E. de From.; OXYSMILIA, Duchass.

Trismilia, E. de From., a very interesting form, is placed here provisionally. *Lophosmilia* becomes a subgenus.

Tribe I.

Genus PLACOSMILIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 467 (1848), *amended.*

Syn. *Phyllosmilia*, E. de From.

Corallum simple, free, subpedicellate, compressed. Calice elliptical, long or short. Columella lamellar. Septa numerous, slightly exsert or not, entire, granular laterally. Costæ well developed or fine, simple or ramified. Endotheca abundant. Exotheca variable, membranous, may be absent.

Distribution.—Fossil. Cretaceous: England, Europe. Eocene: Europe.

Genus LOPHOSMILIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 467 (1848).

Syn. *Oxysmilia*, Duchass.

The corallum is simple, fixed, subturbinate, straight or curved. Calice nearly circular, or slightly oval and elliptical; fossa shallow. Columella lamellar, lobed more or less, or entire. Septa entire, exsert, unequal, granulated on the sides. Costæ distinct to the base. Endotheca scanty. Epitheca absent or rudimentary.

Distribution.—Fossil. Cretaceous: Europe.—*Recent.* Caribbean Sea.

Subgenus PLESIOSMILIA, (genus) *Milaschewitsh, Palæontographica*, vol. xxi. p. 189 (1876).

Corallum simple, cylindro-conical, with circular accretion-ridges, free or adherent. Calice circular, or slightly elliptical, deep

centrally. Columella small, lamellar. Septa numerous, exsert at the margin, upwardly curved, and sloping to the columella, entire, granulate, granules in rows parallel with the free edge. Endotheca abundant. Epitheca membranous, smooth, covering the costæ here and there, not perfect.

Distribution.—Fossil. Oolite: Nattheim, Europe.

This genus is too closely allied to *Lophosmilia* to stand. It is clearly an epithecate subgenus.

Genus PLEUROSMILIA, *E. de Fromentel, Bull. Soc. Géol. de France*, 2e sér. t. xiii. p. 853 (1858).

Corallum simple, variable in shape and height, tall or short, subturbinate, conico-cylindrical. Calice circular or elliptical. Columella lamellar, projecting or not, united to a large septum, which is more developed than the others. Septa numerous, entire. Endotheca exists. Epitheca strong, covering the wall.

Distribution.—Fossil. Jurassic: Europe.

The genus *Trismilia*, E. de Fromentel, Introd. à l'étude &c. p. 106, is stated to be "très voisin des Pleurosmilies," but to differ by having only three primaries developed, and a columella pyramidal and triangular in shape. One species, from the Portland Oolite of France, is noticed.

At present this genus had better be associated with *Pleurosmilia*.

Genus PEPLOSMILIA, *Milne-Edwards & Jules Haime, Brit. Foss. Corals, Pal. Soc., Introd.* 1848, p. xxv.

Corallum simple, adherent by a large base, and is cylindrical. Calice circular or suboval; fossa well developed, with a lamellar columella at the bottom. Septa entire, broad, arched, but very slightly exsert at the margin, striated, entire. Endotheca abundant. Epitheca strong, membraniform, complete.

Distribution.—Fossil. Cretaceous: England. Laube places the genus in the St. Cassian strata of Europe.

Genus BLASTOSMILIA, *Etallon, in E. de Fromentel, Introd. à l'étude des polyp. foss.* p. 107 (1858–1861) (*non Duncan*).

Corallum simple, elongate, slightly bent at the base, and subcylindrical. Calice round and deep. Columella strong and compressed. Septa in four cycles, moderately thick and slightly

exsert. Costæ close and subequal. Endotheca moderately abundant. Epitheca complete, with accretion-ridges hiding the costæ.

Gemmation from the everted margin of the calice at certain epochs of growth. Buds become detached and leave a scar.

Distribution.—Fossil. Oolite: Europe.

Tribe II.

Genus SPHENOPHYLLIA, *Moseley, Report on Corals 'Challenger' Expedition*, 1879, p. 182, pl. x. fig. 1.

Corallum solitary, free, pedicellate, compressed, with septa finely denticulate at the summits, and numerous wedge-shaped costæ, which are denticulate, rendering the corallum exceedingly rough. A scanty epitheca at the base; no endotheca or exotheca. A well-developed lamellar columella.

Distribution.—Recent. Locality unknown.

Moseley places this form amongst the Astræidæ of Dana, in spite of his not observing endotheca. After much consideration I agree, but I am not satisfied that some endotheca does not exist near the columella.

III. Alliance LITHOPHYLLIOIDA.

Simple corals, with entire or dentate, incised or spined septa, endotheca, and a spongy or trabeculate columella. Wall costulate and naked, or with an epitheca.

Tribe I. With entire septa.
„ II. With dentate septa.

I. Genus PARASMILIA, Ed. & H.
Genus DASMOSMILIA, de Pourtalès.
Genus CONOSMILIA, Duncan.
II. Genus LITHOPHYLLIA, Ed. & H.
Genus CIRCOPHYLLIA, Ed. & H.
Subgenus LEPTAXIS, Reuss.
Subgenus ANTILLIA, Duncan.

Genera absorbed:—

CYLICOSMILIA, Ed. & H.; CŒNOSMILIA, de Pourtalès; ANOMOCORA, Studer; CYATHOPHYLLIA, E. de From.; SMILOPHYLLIA, E. de From.; SYZYGOPHYLLIA, Reuss; CYNARINA, Brügg.; SCOLYMIA, Haime; HOMOPHYLLIA, Brügg.

***Leptaxis* and *Antillia* become subgenera.**

Amongst the Simple Corals with plain entire septa are some which have been grouped generically, according to the presence of abundant endotheca or its comparative absence. This is not a sufficiently important distinction. Thus the genus *Cylicosmilia*, Milne-Edwards and Jules Haime, 1848, really only differs from *Parasmilia* of the same authors by its more numerous septa and well-developed endotheca. The first-named genus is of Eocene age and the other is Cretaceous.

It is necessary to absorb *Cylicosmilia* in *Parasmilia*, and to alter the generic diagnosis of the latter slightly.

Pourtalès originated the genus *Cœnosmilia*, 'Deep-sea Corals Hasslar Expedition,' p. 39 (1874), but in the description of the corals of the 'Blake' Expedition he withdrew it, and placed the species in *Parasmilia*.

Tribe I.

Genus PARASMILIA, *Milne-Edwards & Jules Haime* (*Compt. rend.* 1848), and *Brit. Foss. Corals, Introd., Pal. Soc. Lond.* 1849, p. xxv, *amended*.

Syn. *Cœnosmilia*, Pourtalès; *Anomocora*, Studer; *Cylicosmilia*, Ed. & H.

The corallum is simple, fixed, subturbinate, or conico-cylindrical. Calice circular in outline. Columella spongy. Septa entire, exsert, well developed, granular laterally. The wall is naked and costulate. Endotheca exists.

Distribution.—Fossil. Cretaceous and Eocene: Europe. Cretaceous: England.—*Recent.* Caribbean Sea, Philippines.

Pourtalès named the species *Parasmilia Lymani* and *P. variegata*, from the Florida seas; but in his last work, on the 'Blake' corals, he considered them very abnormal, and therefore established the genus *Dasmosmilia* for them. But he retains *Parasmilia fecunda*, Lindström (Pourtales, sp.), and notices that the gemmation is not real, but that the young forms have settled on a dead one.

Genus DASMOSMILIA, *Pourtalès, Bull. Mus. Comp. Zool., Report on Corals dredged by 'Blake' Expedition*, p. 108, pl. ii. figs. 11 & 12 (1880).

Corallum turbinate, with very thin wall and false pali. Columella formed by lobes of the septa. Rudimentary epitheca.

Distribution.—Recent. Off Grenada, in 164 fms.

The species *Dasmosmilia variegata*, Pourtalès, has for its synonyms *Parasmilia variegata*, Pourt., and *Bathycyathus elegans*, Studer.

Genus Conosmilia, *Duncan, Fossil Corals from the Australian Tertiaries, Ann. & Mag. Nat. Hist.*, Sept. 1865, p. 3, pl. viii. figs. 3–5. 3 species.

Corallum simple, pedicellate, conical. Calice elliptical. Columella of one or two twisted laminæ, essential. Septa entire, octameral or hexameral in arrangement, arise at the margin between the costæ. Costæ broad, ornamented or sharp at the margin, and broad below. Endotheca sparingly developed. Epitheca absent or pellicular and ornamented.

Distribution.—Fossil. Australian Tertiaries.

This genus I now place amongst the Trochosmiliaceæ instead of amongst the Madreporaria Rugosa.

Tribe II.

Genus Lithophyllia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 290 (1857).

Syn. *Scolymia*, Haime; *Cynarina*, Brügg.

The corallum is simple and largely fixed, turbinate, subturbinate, cylindro-turbinate, cylindrical, or even prismatic in shape. The wall has well-developed spined costæ. The calice is shallow, circular or subcircular. The septa are well developed, broad, numerous, very granulated on the sides, spinulose on the free edge. Columella well developed, spongy, flat above and a little sunken; its trabeculæ are lamellar and twisted. Epitheca absent. Endotheca largely developed.

Distribution.—Fossil. Miocene: West Indies and Europe.—*Recent.* Caribbean Sea.

Genus Circophyllia, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 491 (1848).

The corallum is simple, turbinate, or tall and pedunculated. The wall has fine, close, simple granular costæ and a rudimentary epitheca. The calice is circular and shallow; the septa very numerous, broad, exsert, and have the free surface more or less lobed. The columella is large and papillary. The endothecal dissepiments are numerous.

Distribution.—Fossil. Eocene: Europe, West Indies.

The genus *Leptaxis*, Reuss, appears to be a *Circophyllia* with

an elongate columella. It is from the Lower Tertiaries and Oligocene of Europe. It requires further study. It merits the position of a subgenus.

Subgenera :—*Leptaxis*, Reuss ; *Antillia*, Duncan.

Subgenus ANTILLIA, *Duncan*, *Quart. Journ. Geol. Soc.* 1863, vol. xix. p. 28.

Syn. *Cyathophyllia*, E. de From. ; *Smilophyllia*, E. de From. ; *Syzygophyllia*, Reuss ; *Homophyllia*, Brügg.

Corallum simple, variable in shape, with more or less dentate and lobed, or simply dentate or simply lobed septa. A well-developed columella. Costæ variously granulated, tuberculated or crested. Endotheca developed ; sometimes some exotheca between the costæ. Epitheca strong, folded, and reaching to various heights.

Distribution.—*Fossil.* Jurassic : England and Europe. Eocene : Europe, Asia. Miocene : West Indies, Asia.—*Recent.* Caribbean Sea, Indian Ocean, Red Sea, Japanese seas, N. Australia.

This subgenus has a well-marked facies which separates it from typical *Circophylliæ*.

M. de Fromentel mistakes my definition of *Antillia* ('Pal. Franc., Terr. crét.' tom. viii. livr. 24, p. 293), and gives *Antillia* a lamellar columella. Having established *Smilophyllia* for Lithophylliaceæ with lamellar columellæ, he withdraws it into *Antillia*. This is an error. In no place have I given *Antillia* a lamellar columella ; it has nothing of the kind. The genus *Smilophyllia* must therefore lapse in the subgenus *Antillia*, Duncan*. M. de Fromentel's genus *Cyathophyllia* is the same as *Antillia*, which has the preference from age. The first-named genus lapses therefore.

Syzygophyllia, a genus established by Reuss, is the same thing as *Antillia*, and must be absorbed. Zittel unfortunately has not seen the original diagnosis of *Antillia*, and has abstracted from M. de Fromentel's translation.

The free or attached condition of corals having the other specific or generic characters in common is not sufficient to establish a distinction. The genus *Caryophyllia* has free and adherent species ; and the species *Caryophyllia clavus* has free, pedunculate, and broad-based and adherent individuals. Hence

* Zittel, 'Handb. Palæont.' p. 650, mentions *Smilophyllia*, Fromentel, as a synonym of *Antillia*.

in dealing with the present group of Simple Corals genera must not be admitted on the fact of the forms they might include being fixed, when the other structural details resemble those of well-known genera whose species are free. Hence *Cynarina* of Brüggemann, 1877, is a free *Lithophyllia*, and *Homophyllia*, Brüggemann, 1877, is a fixed *Antillia* or a young compound coral or colony.

IV. Alliance ASTEROSMILIOIDA.

Simple Astræadæ, turbinate, horn-shaped. Calice elliptical or circular. Wall costulate. One or more rows of pali. Columella variable, elongate, spongy or lamellary or fasciculate, or none. Endotheca exists.

Tribe I. Septa entire.
„ II. Septa denticulated.

I. Genus ASTEROSMILIA, Duncan.
Genus STEPHANOSMILIA, E. de From.
Genus CYATHOSMILIA, T. Woods.
II. Genus PATTALOPHYLLIA, d'Achiardi.

Tribe I.

Genus ASTEROSMILIA, *Duncan, Phil. Trans.* 1867, p. 653.

The corallum is simple, long, cornute more or less. Calice elliptical or circular. Columella solid, essential, compressed, lamellar, short. Septa numerous, entire, and exsert. Costæ irregular and often crested. Pali exsert, in several crowns, before all septa except the last cycle. Endothecal dissepiments distinct, tolerably numerous, and curved.

Distribution.—*Fossil.* Eocene, Miocene: West Indies.—*Recent.* Florida and Atlantic.

This genus was placed as *Trochocyathus* even after the endothecal dissepiments were discovered by Lonsdale (Quart. Journ. Geol. Soc. vol. xx. 1864, p. 26). In May 1867 the generic diagnosis was read before the Royal Society.

The next genus, *Stephanosmilia*, E. de Fromentel, is allied to *Asterosmilia*, Dunc., the generic distinctions being that the first named has a fasciculate columella and two crowns of pali; whilst the other has pali before all the septa except those of the last cycle, and there are four and often five cycles of septa.

There is a very remarkable manner of founding a genus illustrated in the 'Paléontologie Française.' A species is named and

figured years before the letterpress relating to it and the genus is published. Zoologists have long since decided against any such proceeding. The genus dates from the time of reading in or publication by a Society, or periodical, or book. Another method is more remarkable, and consists of diagnosing genera the species of which have not been found.

STEPHANOSMILIA, *E. de Fromentel, Pal. Franç., Terr. crét.* (*non Reuss*), t. viii. Livr. 22, p. 242, 1867 (pl. 26, date 1862, without letterpress).

Corallum trochoid and pedicellate. Wall naked. Costæ well developed, nodular. Columella fasciculate. Septa exsert. Pali well developed, and placed before the septa of the first two cycles. Endothecal dissepiments rather distant.

Distribution.—Fossil. Gault: Europe. Eocene: Borneo.

M. de Fromentel really published the genus in 1867, having figured it only, five years before. He placed it at first amongst styliform columellate *Trochosmiliæ*.

Stephanosmilia, Reuss, is a synonym of *Trochocyathus*.

The following genus is thoroughly Australian in its strangeness.

Genus CYATHOSMILIA, *Tennison Woods, Trans. Phil. Soc. Adelaide, S. Australia*, 1877–78, viii. p. 113.

Corallum simple, pedicellate. Calice elliptical. Columella absent. Pali present. Costæ exsert. Endotheca plentiful.

Distribution.—Fossil. Australian Tertiary deposits.

Tribe II.

Genus PATTALOPHYLLIA, *d'Achiardi, Mem. della Soc. Italia di Sci. Nat. Milano*, tom. iv. no. 1, 1868, p. 3.

Corallum simple, free, cornute. Pali before the antepenultimate cycle of septa. Columella absent. The septal laminæ finely and regularly denticulated. Endothecal dissepiments not very abundant.

Distribution.—Fossil. Eocene: Europe.

The figures given by d'Achiardi in vol. ii. no. 4 of the above work show a coral with a narrow pedicellate end, curving and swelling to the long elliptical calice. The costæ are seen; and there is no epitheca. The pali form a crown of lobes within the septal edges, and there is no columella.

Group-Genus AXOSMILIA.

Simple corals with entire septa, an essential styliform columella, a well-developed epitheca and endotheca.

Genus Axosmilia, Ed. & H.

Genus Axosmilia, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 467 (1848).

The corallum is simple, free in adult age, tall, turbinate or conical. Calice circular and deep. Columella essential, styliform. Septa entire, not exsert, and some unite with the columella. Epitheca complete and membraniform. Endotheca moderately developed in the deep interseptal loculi.

Distribution.—Fossil. Oolitic, Jurassic: Europe.

2. Subfamily *Astræidæ reptantes.*

(The Astrangiaceæ, *Ed. & H.*)

Colony composed of short corallites which arise by gemmation from stolons or basal expansions, which may or may not contain sclerenchyma. Endotheca moderately abundant. Septa both entire and denticulate. Rarely gemmation from the corallite wall.

The living polypes of a form belonging to this group, *Cylicia rubeola*, Quoy & Gaimard, stand up higher than the calices, and the disk is well rayed, and within the margin are little slender tentacles surrounding a long mouth with incised margins (Milne-Edwards & Jules Haime, Hist. Nat. des Corall. vol. ii. p. 607, 1857–60, from Quoy & Gaimard, Voy. de l'Astrolabe, Zooph.). Verrill states ('Notes on Radiata,' p. 526) that *Astrangia palifera*, Verrill, has subpellucid polyps which rise considerably above the calices: the tentacles are long, slender, and covered with white verrucæ, with a knob at the end.

The corallites may be close or rather distant; and in the first instance the bases often overlap, and the gemmation seems to have been from the very basal edge. In one group (*Cœnangia*) the gemmation is partly as in *Cladocora*, and is from the wall of the parent corallite, and the cavities of the bud and parent communicate.

The small colonies of the *Astræidæ reptantes* are readily distinguished from any other forms of the family by their method

of growth. Eight genera were included in the subfamily by Milne-Edwards & Jules Haime; Gosse, de Fromentel, d'Orbigny, Verrill, Reuss, Keferstein, T. Woods, and de Pourtalès added others to the group. Some of the genera were established on morphological data which were not of more than specific classificatory value; and they have been absorbed.

The *Astræidæ reptantes* correspond to the *Turbinolidæ reptantes* of the family Turbinolidæ; and they have great affinities with the Oculinidæ. No division can be made between the "Alliances" of the subfamily from the morphology of the septal edges; for some septa may be smooth and others denticulate in the same calice in many genera. It is an important consideration, for it lays the foundation of a doubt regarding the value of the Eusmiline and Astræid groups of Milne-Edwards and J. Haime.

The subfamily *Astræidæ reptantes* (Astrangiaceæ, Ed. & H.) contained nineteen genera. But after revision eleven genera and two subgenera remain, which arrange themselves under two Alliances. Four genera are removed to other groups.

Alliances.

I. Rhizangioida.
II. Astrangioida.

I. Alliance RHIZANGIOIDA.

Astræidæ reptantes with a complete epitheca, with or without pali. Septa denticulate on the free edge, the primaries sometimes with a subentire edge.

Genus Cylicia, Ed. & H.
Genus Scolangia, T. Woods.
Genus Cryptangia, Ed. & H.
Genus Rhizangia, Ed. & H.
Genus Bathangia, Keferst.

Genus Cylicia, *Milne-Edwards & Jules Haime, Polyp. foss. des terr. paléoz.* p. 116 (1851); *Hist. Nat. des Corall.* vol. ii. p. 606, 1857–60 (*Culicia*, Dana, 1846).

Colony spread over surfaces, and composed of close or rather distant but independent corallites. These are short, subcylindrical, often oblique, with a large base. Calices subcircular and rather deep. Columella papillary and well developed. Septa thin, close, not exsert, the principal with a subentire margin, the others very

dentated. Epitheca complete. Endotheca exists. Gemmation from the base or from a short or long calcareous stolon of the parent corallite.

Distribution.—Recent. Cape of Good Hope, Natal, Australian seas, New-Zealand seas, Singapore.

It is probable that *Solenastræa Prestwichi*, Duncan, of the Crag, is a crowded *Cylicia* with an abnormal growth of exotheca.

Genus SCOLANGIA, *Tennison Woods, Palæont. New Zealand, Corals and Bryozoa*, p. 18 (1880).

Astrangiaceæ united by a calcareous stolon which covers the wall with concentric layers. Corallites inclined. No spiniform processes on the septa. No columella.

Distribution.—Fossil. Tertiary: New Zealand.

In the solitary specimen of the solitary species there does not appear to be a complete calice in the delineation given. The fossa was wide. It may be supposed that the stolon mentioned above means epitheca.

Genus CRYPTANGIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 609 (1857).

Colony budding by stolons which do not become calcareous. Corallites quite free amongst themselves, elongate, cylindro-turbinate, and with a complete epitheca. Calices circular or subcircular; fossette well marked, deep. Columella papillary and well developed. Septa thin, dentate, moderately close. Endotheca exists. Habit: surrounded by and immersed in *Celleporæ*.

Distribution.—Fossil. Miocene: Europe. Pliocene: England.

The species of this genus are always found immersed in *Celleporæ*; and this and their corallite shape and dentate septa of all ages separate it from *Cylicia*.

Genus RHIZANGIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci. Nat.* t. xxvii. p. 496 (1848).

Colony forming expansions of calcareous basal structures from which corallites arise. Corallites rather close, short, sometimes very much so, subcylindrical, largely fixed by the base. Calices circular, almost superficial. Columella papillary, the outer part resembling the inner teeth of the septa. Septa numerous, rarely exsert, large, thin, subequal, granular, close, minutely denticulate where free. Epitheca complete. Endotheca exists.

Distribution.—Fossil. Cretaceous, Eocene, Miocene: Europe. Eocene: Borneo.

Lütken having found a recent species of *Cladangia*, states that when it is young it resembles *Rhizangia*, and that the stability of this last genus is lost. But it is necessary to compare adult forms in zoological argument; and the adults of the two genera differ materially.

Genus BATHANGIA, *Keferstein, quoted in Zittel, Handb. der Palæont.* 1879.

Corallites short, united to a permanent basal enlargement. Calices round and very deep; wall thick, covered with a granular folded epitheca. Columella spongy, well developed, filling the lower part of the corallites. Septa narrow. Pali in one crown.

Distribution.—Fossil. Oligocene: Europe.

It is presumed that endotheca exists. Otherwise the genus will belong to the *Turbinolidæ reptantes*, nobis.

II. Alliance ASTRANGIOIDA.

Astræidæ reptantes with a naked and costulate wall.

Genus ASTRANGIA, Ed. & H.
Subgenus CŒNANGIA, Verrill.
Subgenus PHYLLANGIA, Ed. & H.
Genus ULANGIA, Ed. & H.
Genus STYLANGIA, Reuss.
Genus COLANGIA, Pourtalès.
Genus CLADANGIA, Ed. & H.
Genus LATUSASTRÆA, d'Orb.

Genera absorbed:—
HOPLANGIA, Gosse; PLEUROCŒNIA, d'Orb.

Genera becoming subgenera:—
CŒNANGIA and PHYLLANGIA.

Genera removed:—
PSAMMOPHORA, PLACOPHORA, HOLANGIA, and STYLANGIA, E. de From.

Genus ASTRANGIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 496 (1848).

Colony incrusting. Corallites short, arising from calcareous basal expansions, close, more or less turbinate or cylindrical. Calice circular, deep, and large. Columella papillary, and formed of a network of trabeculæ with additions from the septal ends; outer papillæ resembling those of the septa, or differing in consequence of a large paliform tooth being on some septa. Septa

unequal, not exsert, some united, granular at the sides, denticulate, and often with a paliform tooth. Costæ visible on the wall near the calice especially. Epitheca absent. Dissepiments few and distant.

Distribution.—Recent. East Indies, Florida, Central America, Panama Bay, east and west coasts of North America, Str. of Magellan.—*Fossil.* Eocene: Europe, Borneo. Miocene: N. America.

There is no doubt that the species formerly classified with *Astrangia*, and which are found in the Miocene or later Tertiaries of the United States (eastern coast) vary in their method of gemmation. The corallites may entirely arise from the basal expansion, or some may come from the angles between corallites, and even from the wall anywhere below the calice. Some of these buds are accidentally placed, and have no intimate union with the parent; but others appear to be true infracalicular gemmations. Verrill has formed a subgenus *Cœnangia* for these forms and for *Astrangia Danæ* of the Virginian fauna.

Subgenus CŒNANGIA, *Verrill, Notes on Radiata*, p. 530 (1869).

Syn. *Pleiadia*, Dana.

Corallites united together laterally, forming small *Astræa*-like incrusting masses, sometimes rising into lobes in the middle. Calicles angular and crowded. Septa without distinct paliferous teeth at base, those of the last cycles curved towards and usually united to those of preceding cycle. Columella small, scarcely papillose. Budding between corallites and around or below calicular margin.

Distribution.—Recent. Guaymas; E. coast N. America as far north as Long Island Sound.—*Fossil.* Miocene: Maryland.

Pleiadia, Dana, is not mentioned in Verrill's revision of the names of the genera used in the great work on Zoophytes, Wilkes Expedition; and Dana observes ('Corals and Coral Islands,' 1872, p. 68) that it is synonymous with *Astrangia*.

The genus *Phyllangia* of Milne-Edwards and Jules Haime only differs from *Astrangia* in having exsert septa, some of which are not denticulate, others being so, with a smaller and more variable columella. It is at the most only a subgenus.

Subgenus PHYLLANGIA, (genus) *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 497 (1848); *Verrill, Notes on Radiata*, p. 531.

Syn. *Hoplangia*, Gosse.

Colony incrusting, forming clusters of moderately large turbi-

nate corallites, close or rather distant. Corallites rather short. Calices circular, except where crowded, deep. Columella small or well developed, trabeculate from the septal ends; with from one to three or four pillars rising from the base and uniting and joining the trabeculæ; upper surface ragged or papillose. Septa well developed, numerous, unequal, some exsert, entire or minutely denticulated, granular, with or without paliform lobe. Costæ usually well developed. Epitheca wanting. Endotheca moderate. Basal expansion spreading, calcareous.

Distribution.—Recent. West Indies, Panama, Florida, British Channel? Malacca, W. coast of North and Central America.—*Fossil.* Eocene, Miocene: Europe.

Mr. S. O. Ridley has shown that *Phyllangia*, like *Cœnangia*, Verrill, may sometimes bud from the wall of the parent corallite.

I believe that *Hoplangia*, Gosse, Actin. Brit. p. 338 (1860), is synonymous with *Phyllangia*.

Genus ULANGIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 617 (1857); *corrected in accord with Verrill, Notes on Radiata*, p. 533 (1868).

Colony scattered, basal expansion not developing sclerenchyma. Corallites distant, very low and broad, with a well-developed papillary columella and very numerous septa, the higher orders of which are very denticulate, and the others exsert and partly plain. Costæ near the calice, and an epitheca near the base. Endotheca exists.

Distribution.—Recent. Panama and Philippines.

Genus STYLANGIA, *Reuss, Pal. Stud. über die alt. Tert., Denksch. der Kais. Akad. der Wiss. Wien*, 1874, p. 11.

Colony incrusting. Corallites short, united by basal expansions. Calice circular, moderately deep. Columella styliform. Septa unequal, not exsert. Costæ visible on the wall. Epitheca and endotheca exist.

Distribution.—Fossil. Eocene: Europe.

Genus COLANGIA, *Pourtalès, Illust. Cat. Mus. Comp. Zool. Harvard*, No. iv. 1871, *Deep-Sea Corals*, p. 31.

Corallum immersed in an expanded basal epithecal membrane, forming several successive storeys following the growth of the

coral. Primary and secondary septa entire and exsert; those of the higher orders denticulate and not exsert. Well-developed pali in front of the tertiaries. Columella lamellar or papillose, and not much developed.

Distribution.—Recent. Florida seas and off Havana.

Genus CLADANGIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 618 (1857).

The colony arises from a common basal expansion. Corallites with septa having lobed margins. Columella parietal. An exotheca extends from corallite to corallite, giving the appearance of a vertical series of folia.

Distribution.—Fossil. Miocene: France.—*Recent.* India (*Lütken*).

There are two genera of this subfamily which are exceedingly unsatisfactory owing to the paucity of species and the very indifferent specimens. They are *Latusastræa*, d'Orb., and *Pleurocœnia*, d'Orb. Milne-Edwards and Jules Haime unite these genera.

Now *Latusastræa* has a species from the Oolite of Nattheim, and the specimen figured by Becker and Milaschewitsch, 'Palæontographica,' vol. xxi. plate 40. fig. 1, shows sufficient structure to prove that the genus under which it should be arranged is not *Pleurocœnia*. On the other hand, this last-named genus is not sufficiently defined.

Genus LATUSASTRÆA, *d'Orb. Note sur des Polyp. foss.* p. 7 (1849). (Amended after Becker and Milaschewitsch, 'Palæontographica,' vol. xxi. p. 166.)

Colony in disk-like or crateriform masses, thin and spreading. Base covered with a stout concentrically-folded epitheca. Corallites close, inclined in one direction, low. Calices with a projecting lip, otherwise circular. Columella absent. Septa very irregular in size and distribution. A long columellary septum reaching two thirds of the distance from one side of the calice to the other. Costæ as delicate striations down the wall. Gemmation close to the bases of the corallites from the common basal structure.

Distribution.—Fossil. Jurassic: Europe. Cretaceous: Europe?

The genus *Pleurocœnia* is therefore abolished, and is probably synonymous with the above.

3. Subfamily *Astræidæ gemmantes.*

(Subgroup *Stylinaceæ independentes*, Ed. & H., and Subfamily *Cladocoraceæ*, Ed. & H., combined.)

Astræidæ increasing by gemmation from the wall below the calicular margin. Buds free more or less by their sides. Septa dentate or entire. Endotheca dissepimental.

The subfamily unites the former Eusmilinæ, which were grouped with the Stylinæ, with the Cladocoraceæ of the Astræidæ. Five tolerably well-marked Alliances may be mentioned, and there are some genera which cannot be placed in Alliances.

Fourteen genera are retained and one lapses. The Alliances are the *Cladocoroida*, *Goniocoroida*, *Dendrosmilioida*, *Stylosmilioida*, *Palæastræoida*, and a solitary genus.

I. Alliance CLADOCOROIDA.

Cladocoraceæ or Astræidæ gemmantes bush-, or branch-shaped, or fasciculate, with a papillary columella and pali. Endotheca present.

Genus CLADOCORA, Ed. & H.

Genus PLEUROCORA, Ed. & H.

The genus *Anomocora*, Studer, placed by that author in the Cladocoraceæ, is, according to E. Pourtalès, a *Parasmilia* with buds on a dead parent. This may be the case, but the genus is described by Studer, Obersicht der Steinkorallen &c. Gazelle Reise, Monatsber, Berlin, 1877, p. 641, pl. 9.

Genus CLADOCORA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 588 (1857).

Colony bush-shaped or branched or fasciculate. Corallites variable in length, erect, often flexuous, cylindrical, and free laterally. Calices circular and shallow. Columella well developed. Septa exsert, subequal, rounded, and finely dentated and granulated laterally. Pali exist before all the cycles except the last. Wall compact, moderately thick. Costæ simple, granular, or finely echinulate, straight. An incomplete epitheca, which often gives rise to horizontal collarettes, may extend from one corallite to another. Endotheca scanty. Gemmation lateral and often in pairs from the same height on the stem.

Distribution.—Fossil. Jurassic, Cretaceous, Miocene, Pliocene: Europe. Cainozoic: Australia.—*Recent.* West Indies, Mediterranean, Madeira.

Genus PLEUROCORA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 601 (1857).

Colony subdendroid, espalier-like, or massive. Corallites cylindrical, short, united to the stems, whence they bud for a distance, free at their summits for a variable extent. Calices circular and shallow. Columella papillary, and there are pali before all the septa except those of the last cycle. Septa hardly exsert, subequal, thin, close, denticulate, and granular. The wall is compact, very thick, and the costæ are distinct along the whole height, and are close, separated by deepish grooves, straight near the calice and more or less vermiculate elsewhere. Gemmation lateral. Endotheca exists. Epitheca absent.

Distribution.—Fossil. Cretaceous: Europe.

II. Alliance GONIOCOROIDA.

Astræidæ gemmantes with a dendroid or fasciculate form. Columella rudimentary, granular costæ. No epitheca. Endotheca exists.

Genus GONIOCORA, Ed. & H.
Genus RHABDOCORA, E. de From.

Genus GONIOCORA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 604 (1857).

The colony is dendroid. Parent corallites tall, cylindrical. Offshoots by gemmation free laterally, and forming different angles with the parent according to the species. Calices circular and columella rudimentary. Septa not numerous, spinulose. The wall is naked and has granular costæ, straight and distinct over the whole surface.

Distribution.—Fossil. Trias, Lias: Europe. Oolite: Europe and England.

Genus RHABDOCORA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 432 (1872).

Colony dendroid, in close bush-shapes. Corallites free to a variable extent and generally well costulated. The calice is circular and shallow. There is neither columella nor pali. Septa dentated.

Distribution.—Fossil. Cretaceous: Europe.

III. Alliance DENDROSMILIOIDA.

Astræidæ gemmantes with small subdendroid forms. The corallites short. Columella spongy or parietal. Septa entire. Endotheca present.

Genus Pourtalosmilia, Duncan.
Genus Dendrosmilia, Ed. & H.

Genus Pourtalosmilia, *Duncan.*

Syn. *Blastosmilia*, Duncan (a name preoccupied), Madreporaria of the Deep Sea, Trans. Zool. Soc. vol. x. pt. 5, 1878, p. 244.

Colony formed by repeated gemmations from the wall of the parent corallite, and occasionally from the walls of buds. Corallites conico-cylindrical, long, bent, except the straight parent, and parallel with this last. Calices circular, deep. Columella rudimentary, or as trabeculæ from the septal ends. Septa entire, thin, slightly exsert; they project but slightly into the calice, except the primaries and secondaries. Costæ rudimentary and only exist near the calices. Wall thin, with a granular epitheca closely attached. Dissepiments wide apart.

Distribution.—Recent. Mediterranean.

It must be noticed that the parent corallite survives with the buds and does not die, as in *Anomocora* and *Cœnosmilia.*

Genus Dendrosmilia, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 468 (1848).

Colony small, subdendroid, increasing by lateral and alternate gemmation. Corallites subturbinate, short, free by their sides. Calices suboval. Columella spongy, well developed. Septa entire, thin, close, very unequal and granulated on their sides. Costæ broad, simple, and granular. Endotheca present. No epitheca.

Distribution.—Fossil. Cretaceous and Eocene: Europe.

IV. Alliance STYLOSMILIOIDA.

Astræidæ gemmantes with fasciculate, tufted, dendroid forms. The septa entire or dentated. The columella stout, styliform, or papillary.

Genus Stylosmilia, Ed. & H.
Genus Stylocora, Reuss.
Genus Stylocora, E. de From., 1872.
Genus Placophyllia, d'Orb.
Genus Donacosmilia, E. de From.

Genus Stylosmilia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 220 (1857).

Colony in tufts which are fasciculate. Gemmation lateral.

Corallites cylindrical, close, long, flexuous, and coalescent in places, free elsewhere. Calices circular. Columella well developed, styliform and projecting. Septa entire, few, slightly exsert, joining the columella by means of horizontal spiniform projections. Epitheca present or not. Endotheca simple and scarce.

Distribution.—Fossil. Oolite, Cretaceous: Europe.

Genus STYLOCORA, *Reuss, Zittel, Palæontol.* p. 256.

Colony subdendroid. Corallites cylindrical, short, free at the sides. Calices circular. Columella styliform. Septa denticulate, unequal; the primaries the largest, exsert and granulate laterally. The inner ends of the larger septa with a paliform lobe in contact with the columella.

Distribution.—Fossil. Cretaceous and Miocene: Europe.

It is a misfortune that M. de Fromentel should have chosen the name *Stylocora* for a genus with a papillary columella. I have not been able to find *Stylocora*, Reuss, and do not therefore know the date of its diagnosis and publication.

Genus STYLOCORA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 430 (1872).

Colony dendroid, with slender branches, free to a great extent. Calice circular. Columella well developed and papillary. Pali absent. Costæ well pronounced. Septa dentate, well developed and close.

Distribution.—Fossil. Cretaceous: Europe.

Genus PLACOPHYLLIA, *d'Orbigny, Note sur les Polyp. foss.* p. 8 (1849).

Colony fasciculate or astræiform, increasing by sub-basilar or lateral gemmation. Corallites nearly entirely enveloped in a strong folded epitheca, and often united together without the presence of costæ or exotheca. The columella is strong and styliform. Septa well developed. Endotheca abundant.

Distribution.—Fossil. Oolite: Europe.

The next genus is a very doubtful one, the specimens being in a very miserable condition, and I place it here provisionally.

Genus DONACOSMILIA, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 146 (1858–61).

Colony fasciculate, reaching to a considerable height. Wall

covered with a complete epitheca, forming strong circular ridges, wanting here and there. Calices round. No columella (?). Septa broad, slightly exsert, uniting at the axis. Endotheca well developed. Gemmation lateral, and buds pass up parallel with the parent.

Distribution.—Fossil. Oolite: Europe, England?

V. Alliance PALÆASTRÆOIDA.

Astræidæ which increase by gemmation from the wall of the parent, and also from the calice. Septal number irregular. Costæ occasionally remarkably developed.

Genus HETEROPHYLLIA, M'Coy.
Genus BATTERSBYIA, Ed. & H.

Genus HETEROPHYLLIA, *M'Coy, amended in Phil. Trans. Royal Soc.* 1867, p. 648.

Colony of long and slender corallites, free. Gemmation around the calicular margin. Septa either irregular in number and arrangement, or are only six in number and regularly placed. Costæ well developed, may be tubercular, spined, and flexuous. Wall thick. Endotheca dissepimental. Epitheca absent. Columella absent or produced by junction of the septa.

Distribution.—Fossil. Carboniferous limestone: United Kingdom.

Genus BATTERSBYIA, *Ed. & H., amended in Phil. Trans. Royal Soc.* 1867, p. 648.

Colony fasciculate. Corallites tall, distant, or close and crowded, free, except when arising from a parent, very variable in dimensions in the same colony, or else subequal. Calices and corallites, on section, circular in outline. Columella absent or produced by union of septa. Septa very unequal in size and number, from 6, 12, to 52 in number. Endotheca vesicular and abundant. Gemmation from the walls of corallites, and the buds have five septa or more; also by budding from the interseptal spaces of those buds, of gemmules which develop six septa. There is no epitheca. Corallites without cœnenchyma around them, but often surrounded by *Stromatopora.*

Distribution.—Fossil. Devonian: England.

Solitary genus.

Genus HEXASMILIA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 423 (1871).

Colony fasciculate in close tufts. Corallites free to a great extent, but usually close and polygonal in outline. There are only six septa, which start from the angles of the walls, and one more developed than the others reaches the centre of the calice. Epitheca strong, folded, and reaching to the summit of the colony.

Distribution.—Fossil. Cretaceous: Europe.

The genus *Isocora*, Etallon, is insufficiently determined, and should lapse.

In 1867 a division of the Astræidæ was suggested in order to receive the two Palæozoic genera *Heterophyllia*, M'Coy, and *Battersbyia*, Ed. & H.* I now place this division as an Alliance in those Astræidæ which bud between the calicular margin and the base.

4. Subfamily *Astræidæ cæspitosæ.*

(*Euphylliaceæ cæspitosæ*, Ed. & H. (pars), and *Astræaceæ cæspitosæ*, Ed. & H., combined.)

Astræidæ in which the corallites are isolated in all their terminal portions, being free at their sides, springing from a common parent, increasing by fissiparity, separation occurring rapidly or serial growth persisting. Septa entire or dentate, spined or lobed. Endotheca abundant. Colonies in cæspitose tufts, often more or less foliaceous. Gemmation rare, but it exists more frequently than has been thought hitherto.

The insufficient morphological distinction between the Sections *Lithophylliacées cespiteuses* and the *Euphylliacées cespiteuses* of Milne-Edwards and Jules Haime, Hist. Nat. des Corall. vol. ii. pp. 288 & 184, has been intensified by the fact that there is not a very great difference between the soft structures of the groups. The first section belongs to the Astræinæ, Ed. & H., with spined and dentated free septal edges, and the last to the Eusmilinæ, with smooth septal edges. These conditions of the septal edge, as already noticed, cannot be of physiological importance, and they are found combined in the calices of species of other groups of the corals. Again, the Cæspitose Euphylliaceæ,

* P. Martin Duncan, Phil. Trans. Roy. Soc. 1867, pp. 643, 651.

the second of the sections mentioned above, run into the Euphylliacées confluentes; and this want of definition is observable in the Astræinæ cæspitosæ and confluentes.

It does not seem possible to separate such genera as *Eusmilia*, *Aplosmilia*, and *Euphyllia* from *Dasyphyllia*, *Trachyphyllia*, and *Mussa*, and their subfamily relationship is evident. The genus *Plocophyllia*, Reuss, is an Eusmiline *Mussa* in habit of growth.

In both of the sections the corallites spring from a small base or parent, either by budding or by fissiparity. They then increase by fissiparous division. The divided parts grow upwards, become separate, and do not unite at the sides. Sometimes this fissiparous division does not take place until the calice has become very long, and even gyrose, so that a kind of serial growth occurs before separation, and it may persist in some parts of the colony, or universally. One part of a fissiparous calice may grow faster than the other, and the calicular centres of the new corallites become evident sooner or later in all conditions, except in the long serial gyroid calices seen in *Euphyllia* for instance.

Seventeen genera have been noticed, but thirteen only remain after revision. Two become subgenera.

Alliances.

I. Calamophyllioida.
II. Thecosmilioida.
III. Mussaoida.

I. Alliance CALAMOPHYLLIOIDA.

Cæspitose Astræidæ in colonies, the corallites of which speedily become separate, except at their lower and originally attached part. Calices more or less circular, very rarely forming short series.

Tribe I. With entire septa.
„ II. With dentated and spined septa.

Tribe I.

Genus Eusmilia, Ed. & H.
Subgenus Caulastræa, Dana.
Genus Aplosmilia, d'Orbigny.
Genus Solenosmilia, Duncan.

Tribe II.

Genus Dasyphyllia, Ed. & H.
Genus Calamophyllia, Ed. & H.

Genus Pleurophyllia, E. de From.
Genus Dendrocora, Duncan.
Genus Dactylosmilia, d'Orb.
Genus Hymenophyllia, Ed. & H.
Genus Rhabdophyllia, Ed. & H.

Genera absorbed :—
Aplophyllia, d'Orb.; Caulastræa becomes a subgenus.

Tribe I.

Genus Eusmilia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 186 (1857; founded 1848); *amended.*

The colony is cæspitose in shape, and the branches are dichotomous or trichotomous. The base increases but slightly with age, and the subcylindrical corallites increase in height, multiply fissiparously, and speedily become separate. The calices are large, somewhat irregular in outline owing to fission, but are generally elliptical. The columella is composed of a lax, broad tissue, and is at the bottom of a deep fossa. The septa are entire at their upper edge, are well developed, thin, narrow, and slightly granular. The costæ are subcrestiform near the calices, and may become more or less indistinct towards the base. The endotheca is moderately developed, and there is a pellicular epitheca, which does not pass far up the colony.

Distribution.—Fossil. Antillian Pliocene.—*Recent.* Caribbean Sea.

Eusmilia alticostata, Ed. & H., has the costæ distinct at the base.

Subgenus Caulastræa, *Dana, Zoophytes, Wilkes's Explor. Exped.* p. 196 (1846).

Colony cæspitose, with the stems straight or twisted, subcylindrical. Calices subcircular, deep. Septa unequal, exsert, subentire, rather numerous. The outer surface of the stems striated or denticulate.

Distribution.—Recent. Pacific, West Indies?

The three species included in *Caulastræa,* Dana, form a very natural subgenus of *Eusmilia.*

Genus Aplosmilia, *d'Orbigny, Note sur les Polyp. foss.* p. 6 (1849), *and Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 189; *amended.*

The colony is cæspitose, and the branches are dichotomous or

trichotomous. The base increases but slightly with age, and the corallites grow high, subcylindrical, and increase by fissiparity, separating soon. The calices are large and do not form series. The columella is lamellary. The septa are large, thin, and entire. The costæ are crestiform, and are visible to the base. There is an endotheca, but the epitheca is absent.

Distribution.—Fossil. Oolite of Europe.

Genus SOLENOSMILIA, *Duncan*, *Madreporaria of Deep Sea, Trans. Zool. Soc.* vol. viii. pt. 5, p. 327 (1871).

The colony is bush-shaped, and the corallites, which rarely unite, are cylindrical and bifurcate. Budding occurs, and afterwards fission of the terminal calices: their fossæ and columellæ are in common. The tissue between these calices is costulate, and that over the rest of the corallum granular and without epitheca. The calices increase by fissiparity, and occasionally form short series. Columella formed of laminæ and of the paliform ends of septa, and is deeply situate. Septa variable in number; many reach the columella and have paliform lobes. Dissepiments common. Wall often thick.

Distribution.—Recent. N.E. and S. Atlantic, Caribbean Sea, South Indian Ocean, Philippines, Japan. To 1098 fms.

Tribe II.

Genus DASYPHYLLIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 432 (1848); *Ann. des Sci. Nat.* 3e sér. t. x. pl. 8. fig. 5 (1849).

The colony is fasciculate, and resembles a more or less hemispherical, dichotomous cyme in shape. The corallites grow upwards, divide fissiparously, and become free to a considerable extent rapidly. The calices are circular, suboval, or deformed, moderately deep, and there is a spongy columella. The septa are exsert and dentate, the inner teeth being larger than the outer ones. The endotheca is well developed. The wall is echinulate and costulate, and gives rise to circular expansions. The epitheca is rudimentary.

Distribution.—Fossil. Tertiary of Sind and Miocene of Europe. —*Recent.* East Indies, Malacca.

Genus CALAMOPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 342 (1857).

The colony is fasciculate, and the corallites are long and

dichotomous, free soon or almost entirely so. The calices have an irregular margin, and are more or less circular or subcircular, and they are shallow. The columella is rudimentary, or absent. The septa are numerous, and nearly equidentate. The endothecal dissepiments are oblique and well developed. The wall is naked, or may have a rudimentary epitheca, and is covered with equal or subequal granular costæ. Circular expansions of the wall occur at different heights, and may or may not unite with those of other corallites.

Distribution.—Fossil. Trias: Europe. Jurassic: England and Europe. Secondary: Europe. Tertiary: Europe, Sind, Australia?

Genus Pleurophyllia, *E. de Fromentel, Introd. à l'étude des polyp. foss.* p. 140 (1858–60).

Colony with small dichotomous or trichotomous branches. Corallites cylindrical, multiplying fissiparously. Calices with the septa arranged on the heptameral type, one of the seven large septa being the most developed, and reaches the axis without diminishing in thickness, and replaces a columella. The wall is covered with a thick epitheca, swollen in bourrelets here and there.

Distribution.—Fossil. Portland Oolite: Europe.

Genus Dendrocora, *Duncan, Deep-Sea and Littoral Corals, Proc. Zool. Soc.* 1876, p. 438.

Colony bushy, branching from all parts, frequently in one plane. Branches different in length, slender. Calices terminal, round, shallow or elongate when undergoing fissiparity. Columella lax and trabecular. Septa denticulate, with pali before those of the third cycle. Costæ distinct, broader than the septa of the calicular margin, and are sharply granular over the all. Wall thick. Endotheca tolerably abundant. Epitheca absent. In some branches the fissiparity is repeated to form short series.

Distribution.—Recent. Atlantic, West coast of Africa.

Genus Dactylosmilia, *d'Orbigny, Note sur les Polyp. foss.* p. 6 (1849).

The colony is dendroid, and has dichotomous corallites. The columella is spongy and well developed. The septa are dentate and in three or four cycles, and there are pali before all, with the

exception of the last. The walls are naked, and have distinct granular costæ along their whole length.

Distribution.—Fossil. Cretaceous: Europe.

Genus HYMENOPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 368 (1857).

Colony in the form of a fasciculate tuft. Corallites free at their sides, and environed by a complete epitheca, which is attached to the extremity of the costæ at a little distance from the wall, giving an appearance of a double wall. Calices broad, more or less deformed. Columella rudimentary or none. Septa in irregular cycles, with a paliform lobe. Endotheca very developed.

Distribution.—Fossil. Cretaceous: Europe.

Genus RHABDOPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 348 (1857), *amended.*

Colony in the shape of a dendroid tuft; the corallites long and cylindrical in shape, bifurcating fissiparously and at different angles. The calices have rather irregular shapes, and the columella is spongy and well developed. The septa are dentate and granular. The costæ are continued over the wall to the base, and are distinct and granular, may be restricted to the neighbourhood of the calice, or some are very distinct low down. The endotheca is developed, and there is no epitheca.

Distribution.—Fossil. Trias, Cretaceous: Europe. Jurassic: England and Europe. Eocene: Europe and Asia.

This genus absorbs *Aplophyllia,* d'Orbigny, 1849, which, being less well known, had better not receive the usual priority.

II. Alliance THECOSMILIOIDA.

Astræidæ more or less cæspitose, sometimes submassive. Corallites united to some extent, increasing by fissiparity, speedily separating, showing short series rarely; gemmation may occur.

Genus THECOSMILIA, Ed. & H.

Subgenus CLADOPHYLLIA, Ed. & H.

The genus *Cladophyllia* becomes a subgenus, and *Cœnotheca,* Quenstedt, is abolished.

Some of the genera now about to be considered are very difficult to classify, especially *Thecosmilia,* Ed. & H. The young

of most Thecosmilians were simple forms resembling *Montlivaltiæ*, and growth proceeded for some time without increase, or the reverse happened. The increase was clearly not invariably by fissiparity of the parent; subdivision and upward growth from more than two centres may be noticed; and the method is indistinguishable from the results of gemmation. As growth proceeded the calice either remained unaltered, or fissiparity, or even something like serial growth, developed.

The result in these last two instances was to produce calices as varied in shape as in *Mussa* and *Symphyllia*.

Mr. Tomes, F.G.S., has introduced the genus *Chorisastræa*, E. de Fromentel, to absorb the *Thecosmiliæ* which grow at first by budding and then by fissiparity. In his essay on the Lower-Oolite Madreporaria (Quart. Journ. Geol. Soc. vol. xxxviii. p. 428, 1882), the diagnosis of *Chorisastræa* is not introduced. A figure is given of *Chorisastræa gregaria* on plate xviii. figs. 1–3, the *Thecosmilia gregaria* of Ed. & H., and M'Coy's *Montlivaltia gregaria*.

The figure, however, does not represent the characteristic groove or deep space between the walls of adjoining calices, which is the special generic character of *Chorisastræa* according to the founder of the genus, M. de Fromentel. *Chorisastræa* will be considered in its proper place.

Genus Thecosmilia, *Milne-Edwards and Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 354 (1857).

This colony is usually cæspitose, but sometimes becomes submassive, expanding at the top in consequence of the more or less complete union of a certain number of corallites together. Usually the corallites tend to isolate rapidly by and after fissiparity, and their base develops but little with age. The calicular margins are irregular. The columella is rudimentary or none. The septa are strong, more or less exsert, regularly dentate above and granular laterally. The endotheca is well developed, and the epitheca is stout and strongly folded and reaches close to the calices. Growth by fissiparity and rapid isolation, or by gemmation and subsequent fissiparity.

Distribution.—Fossil. Trias, Jurassic, Cretaceous, Tertiary: Europe. Jurassic: England.

Subgenus Cladophyllia, (genus) *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 363 (1857).

Colony in the form of cæspitose tufts. Corallites elongate,

cylindroid, covered with a well-developed complete epitheca. The calices are circular in outline and rather deep. Septa not numerous. The columella is rudimentary or absent. Endotheca not abundant.

Distribution.—Fossil. Trias, Jurassic: Europe. Jurassic: England.

This was formerly a genus, but it is clearly only a division of that called *Thecosmilia.*

The genus *Cœnotheca,* Quenst., is ill defined, and relates, in all probability, to peduncles of Thecosmilioida.

III. Alliance MUSSAOIDA.

Cæspitose Astræidæ with very dentated or spined septa. Growth by fissiparity. Corallites free at their sides or slightly joined. Calices unsymmetrical, rarely solitary, usually in series, free.

Genus TRACHYPHYLLIA, Ed. & H.
Genus MUSSA, Oken.

Genus TRACHYPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 340 (1857).

Colony fixed, not very tall, composed of corallites which are free amongst themselves, wavy and swollen and contracted here and there. Calices as long valleys, much twisted and deep. Columella well developed, spongy, and lax. Septa numerous, exsert, striated, and highly granular on their sides; the free edge of the larger finely dentate, and lobed towards the columella, and the smaller have larger and narrower dentations. Endotheca exists. The wall has costæ, which are strong, echinulate, and sublamellar. Epitheca rudimentary or incomplete.

Distribution.—Recent. Chinese, Indian, and Red Seas.

This genus=*Manicina,* according to Dana, Zooph. 1846, pl. 9. fig. 1.

Genus MUSSA, *Oken,* 1815, *amended in Milne-Edwards & Jules Haime's Hist. Nat. des Corall.* vol. ii. p. 328 (1857).

The colony is tall, more or less cæspitose. The corallites are united in short or long series, or free, and have the walls either quite ununited or very slightly united. Calices serial or circumscribed, unsymmetrical, and their centres are distinct and deep. The columella is spongy and well developed. The septa large,

numerous, exsert, are spined or strongly toothed, especially near the calicular margin, and the systems are irregularly developed. Costæ spined. Walls striated, and either naked or presenting a rudimentary epitheca. Endotheca well developed.

Distribution.—Recent. West Indies, East Indies, Red Sea, Pacific, China.

The young individuals cannot be distinguished from simple Astræidæ of the *Antillia* type. It is a large genus, and may be divided into those with the corallites free and with calices circumscribed—*Mussæ cymosæ*; and those in which serial growth preponderates—*Mussæ gyrosæ*.

The principal distinction of *Mussa* from the genus *Symphyllia* consists in the perfect union of the walls in this last-named genus.

5. Subfamily *Astræidæ confluentes.*

Astræidæ with entire or dentate, ragged, and spined septa, increasing by fissiparity and having excess of serial growth. Gemmation may occur. Corallites united by their walls, costæ, or by intermediate tissue, or free.

Alliances.

I. Euphyllioida.
II. Eugyroida.
III. Symphyllioida.
IV. Monticuloida.

Forty genera have been recorded, and revision leaves thirty-three. One old genus becomes a subgenus, and six lapse.

I. Alliance EUPHYLLIOIDA.

Colony cæspitose, foliaceous, or flabelliform. Septa dentate or entire. Calices in long series, sinuous or not; not united by their walls or costæ, but free.

Genus Euphyllia, Ed. & H.
Genus Glyphophyllia, E. de From.
Genus Rhipidogyra, Ed. & H.
Genus Teleiophyllia, Duncan.
Genus Desmocladia, Reuss.

Genera absorbed:—
Plocophyllia, Reuss; Stenogyra, E. de From.; Fromentelia, Ferry.

Genus EUPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 191 (1857).

Syn. *Plocophyllia*, Reuss; *Stenogyra*, E. de From.; *Fromentelia*, Ferry.

The colony is cæspitose or subfoliaceous. The base increasing but little with age. The corallites increase fissiparously, and either some separate or others remain united in series of greater or less length. These series are always free at their sides and their calicinal centres remain distinct, except in very long series, where they are indistinct. There is no columella. The septa are very numerous, very thin and exsert, long from the axis to the margin, and often folded a little; their sides are smooth, and the free upper edge is entire. The wall is thin, naked, almost smooth inferiorly, and costulate near the calices. The endotheca is abundant, low down, and vesicular.

The genus is divided into two groups. In the first the colony is in the shape of a cæspitose bush or tuft.

Distribution.—Recent. Pacific, N. Australian seas, and Singapore.

The second group has the colony in the shape of meandroid laminæ of greater or less length.

Distribution.—Fossil. Jurassic, Cretaceous, Eocene, Miocene: Europe, Asia.—*Recent.* Chinese and Indian seas.

M. de Fromentel founded the genus *Stenogyra*, Introd. à l'étude des Polyp. foss. p. 153 (1858); but it does not appear to differ from the second group of *Euphyllia* except in the thickness and granulation of the septa. I propose to absorb it in *Euphyllia*; and therefore the antiquity of the genus is put back to the Jurassic age. Reuss's genus *Plocophyllia* is absorbed in the second group of *Euphyllia*, the species having well-marked costæ to the base.

Genus GLYPHOPHYLLIA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 463 (1877).

Colony in rather thin laminæ, flabelliform, and free at the sides. Calice of one large, shallow series, straight or slightly bent, broad. Columella absent. Septa large and thick, dentate or lobed, thin towards the axis, and usually alternately large and small. Costæ dentate and granular, more or less covered with epitheca.

Distribution.—Fossil. Cretaceous: Europe.

This genus is doubtfully separable from *Euphyllia*.

Genus RHIPIDOGYRA, *Milne-Edwards & Jules Haime, Pol. foss. des Terr. paléoz.* p. 57 (1851).

Colony flabelliform and lamellar, and folded more or less. The corallites are in one narrow flexuous series, and their calices are confluent and not distinguishable. The wall of the series is free. The columella is lamellar. The valley formed by the series is shallow, and the septa are exsert, close, and entire at their free edge. The costæ are straight, and often subcristiform near the calicular margin. Near the base, the wall is either naked or has a rudimentary epitheca. Endotheca abundant.

Distribution.—Fossil. Jurassic and Cretaceous of Europe.

Genus TELEIOPHYLLIA, *Duncan, Proc. Geol. Soc. Lond.* Nov. 18, 1863, p. 34, pl. iii. figs. 5*a*, *b*.

Corallum long, low, narrow, and pedicellate. Calices confluent, forming a nearly straight series. Columella long, lamellar. Septa numerous, close, granular, serrate above. Costæ free and granular. Endotheca and epitheca well developed, and some exotheca between the costæ.

Distribution.—Fossil. Miocene: West Indies.

Genus DESMOCLADIA, *Reuss, Denkschr. der Kais. Akad. der Wiss. Wien*, 1874, Bd. xxxiii. p. 37.

Colony large, massive, bushy or fasciculate. Corallites very long, spring from small bases, and enlarge in series upwards. Series long, gyrose, narrow, not united by their walls. Costæ small. Columella parietal and spongy. Calicinal centres not distinct.

Distribution.—Fossil. Eocene: Europe.

II. Alliance EUGYROIDA.

Fissiparous Astræidæ with confluent serial calices; calicinal centres indistinct, except when young. Walls united directly, or indirectly by exothecal structures, forming a massive colony.

Tribe I. With entire septa.
Tribe II. With dentate or denticulate septa.

I. Genus DENDROGYRA, Ehr.
Genus PECTINIA, Oken.
Genus EUGYRA, E. de From.
Genus PACHYGYRA, Ed. & H.

II. Genus DIPLORIA, Ed. & H.
Genus STIBORIA, Etallon.

Genus MANICINA, Ed. & H.
Genus MÆANDRINA, Ed. & H.
Subgenus CŒLORIA, Ed. & H.
Genus LEPTORIA, Ed. & H.
Genus MÆANDRASTRÆA, Ed. & H.
Genus BRACHYMÆANDRINA, Duncan.
Genus STELLORIA, d'Orb.

Genus PLATYGYRA, Ehr., absorbed. CŒLORIA becomes a subgenus.

Tribe I.

Genus DENDROGYRA, *Ehrenberg, Corall. des roth. Meer.* p. 100 (1834).

The colony is massive and often columnar in shape, or simply convex. The corallites form tortuous series which are completely united by their walls. The calices are confluent and subdistinct in series, and are in shallow valleys between broad, flat, compact collines or ridges. The columella is formed of a series of compact swellings, or of small interrupted laminæ, and is sometimes rudimentary. The septa are very thick, unequal, and close; they are entire. The walls on the ridges are very stout, and sometimes there is a slight depression along the axis of the ridge. Endotheca exists largely. The columns appear to be prong-shaped growths from large hemispherical masses.

Distribution.—Recent. Antilles. Other localities unknown.

The genus *Pectinia* of Oken (1815) in part, and the genus *Ctenophyllia*, Dana, 1846, merged into the genus *Pectinia* of Milne-Edwards & Jules Haime in 1857. The synonymy of the genus and species is given in the 'Hist. Nat. des Corall.' vol. ii. pp. 206–210 (1857).

Genus PECTINIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 206 (1857).

The colony is pedunculate or sessile, grows but little at the base, and presents a large calicular surface. The corallites are united by their walls, and sometimes with some cœnenchyma. The calices are in series, are indistinct; their valleys are very long and broad; and the columella is lamellary, and reaches from one end of the calicular series to the other. The septa are entire, stout, granular, and exsert. There are accessory laminæ (pali?) before the septa of the last cycle attached to the columella. Ridges (collines) well developed, may show inter-

mediate structure, united walls not very stout. Costæ subequal, crested, bifurcating or plain near the base, and more cristiform near the calicular surface. Epitheca rudimentary and inferior Endotheca exists.

Distribution.—Recent. West Indies, Brazils.

Genus Eugyra, *E. de Fromentel, Desc. des Pol. foss. de l'étage Néocomien*, p. 30 (1857).

Colony pedicellate inferiorly, convex on the upper and enlarged surface. Corallites in series, intimately united by their walls. Calicinal valleys meandroid in the centre of the colony, and radiating and straight towards the circumference. Calices indistinct. Columella absent. Septa entire, arched above. Endotheca well developed. A folded and complete epitheca.

Distribution.—Fossil. Cretaceous: Europe.

Genus Pachygyra, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 468 (1848).

The colony is fixed by a thick peduncle, and is enlarged above. It is composed of corallites united by a costal and exothecal cœnenchyma, which is dense and greatly developed, and reaches up to a certain distance below the summit of the walls. Calices in long, flexuous, narrow, shallow series. The columella is lamellary, very thin, and continuous. Septa are entire, thin, close; and the costæ are fine, subplane, and granular. The ridges have a space along their axis, which presents the top of the intermural tissue. Epitheca rudimentary or none. Endotheca exists.

Distribution.—Fossil. Cretaceous and Oolitic: Europe.

Tribe II.

Genus Diploria, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 401 (1857).

Colony massive, spheroidal, hemispherical, or convex, with a large fixed base. Corallites in long series, united by their costæ, which are greatly developed, and between which there is some exotheca. The walls are thick, and in sections their upper edges are free and distinct from those of the neighbouring series. Hence the calicular valleys are separated by rather broad, convex, depressed collines marked on either side by costæ. The calicinal centres are quite indistinct in the very sinuous valley-series, which are deep.

The columella is spongy, essential, and well developed. The septa are stout and exsert, and their dentations are close, subequal.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Asia.—*Recent.* Caribbean Sea, Bermuda, and Chinese seas.

Genus STIBORIA, *Etallon, Lethæa Bruntrutana* (Zurich 1864), p. 386.

Colony massive, adherent by a small surface, and in the form of thin laminæ. Corallites in short series, which are more or less flexuous, united below, and separated above by a groove on top of the intercalicular ridge. Ridge resulting from the incomplete fusion of the corallite-walls. Calicinal centres indistinct. Columella absent. Septa dentate near the axis. An epitheca exists covering costæ of the common plateau.

Distribution.—Fossil. Oolitic: Europe.

Genus MANICINA, *Ehrenberg, amended by Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 397 (1857).

Colony massive, free or pedunculate, broad-based, subhemispherical, tall, and convex or subconical or short. Corallites with their walls fused with those of their neighbours, except in young forms. Calicinal valleys long, broad and deep, united by simple or broad and furrowed collines. Calices with indistinct centres. Columella spongy, essential. Septa close, thin, strongly granulated laterally, the principal with a paliform lobe, and with the free edge divided by fine teeth, which are regular, close, and largest near the columella. The common plateau is furnished with costæ, which are delicate and dentate, and are partly covered by an epitheca, which is readily detached. Endotheca abundant, unequal.

Distribution.—Recent. Caribbean Sea.

Genus MÆANDRINA (pars, *Lamarck*), *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 388 (1857).

Colony massive, dense, convex, gibbose, subplane or subspheroidal, largely fixed by its base. The series of corallites unite by their walls, which are compact, and produce long, simple ridged collines. The valleys are sinuous, long, but vary in length, depth, breadth, and meandroid nature. Calices mostly indistinct, some may be circumscribed. Columella formed by masses of spongy tissue well developed. The septa are close, parallel, their inner edge thickened and enlarged transversely; upper margin denti-

culate, moderately granular laterally. Union of the transverse enlargements of neighbouring septa near the columella often occurs, and gives a paliform appearance. Endotheca and epitheca exist.

Distribution.—Fossil. Oolite: Europe. Cretaceous: Europe. Miocene: Europe; W. Indies; Raised beaches, E. Africa.—*Recent.* Indian seas, E. American seas, Caribbean, Pacific.

A group of forms possessing very variably-shaped calices was once scattered amongst four genera, namely, *Mæandrina*, Lmk., *Platygyra*, Ehr., *Astroria*, Ed. & H., and *Cœloria*, Ed. & H.

Milne-Edwards and Jules Haime united the last two genera, abolished the genus *Platygyra*, and explained the distinct character of *Mæandrina*.

Hence in the 'Histoire Naturelle des Coralliaires' the forms are all placed under the genus *Cœloria*. This is correct, because the characters of *Astroria* and *Cœloria* may be recognized on the same colony. M. de Pourtalès notices how difficult it is to distinguish forms of this genus which have very long calices from *Mæandrinæ*. He proves that some *Cœloriæ* must come within the genus *Mæandrina*. On the other hand, I have shown that the internal structures of *Cœloria pachychila* do not permit it to remain in the genus (Journ. Linn. Soc. vol. xvii. p. 361, 1884).

There does not appear to be any satisfactory reason for separating the genera *Mæandrina* and *Cœloria*; and I consider the latter to be a subgenus of the former. But there is no warrant, as the late Dr. Brüggemann (Phil. Trans. vol. clxviii. p. 571) thought, for resuscitating the name *Platygyra*, Ehr.

Subgenus Cœloria, (genus) *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 411 (1857).

Colony massive, light, largely fixed at the base, hemispherical, convex, rarely subplane. The corallites in series are united by their walls, forming simple interserial ridges. The length of the valleys, which are usually deep, varies greatly, even in the same colony, from that of a simple bud in which the calicinal centre is distinct to that of several centimetres. In the series the centres are indistinct. Columella parietal, and formed by trabeculæ from the ends of the septa, may be spongy. Septa thin, minutely dentate, and granular laterally. Endotheca abundant. In sections the fused walls are slender.

Distribution.—Fossil. Miocene: West Indies.—*Recent.* Red Sea, East Indies, Pacific.

Genus LEPTORIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 405 (1857).

Colony massive, very largely fixed. Corallite series unite by their walls, and the ridges at the surface are always simple, usually thin. The valleys are long, straight, or very sinuous, or both in the same colony. Calicinal centres perfectly indistinct. Columella lamellar, lobed, and projects where free in the series. The septa are slightly exsert, unite to the columella by means of trabeculæ, and their dentations are small and irregular. Endotheca exists.

Distribution.—Fossil. Cretaceous: Europe. Eocene, Oligocene, Miocene: Asia.—*Recent.* Indian Ocean, Pacific, Seychelles, Rodriguez, Red Sea.

Genus MÆANDRASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 452 (1857).

Colony massive, convex. Corallites in series united by their costæ or by their walls. Corallite ridges (or collines) at the surface rather broad, with or without a delicate groove. Valleys numerous, short. Calicinal centres distinct, but united by septo-costæ. Columella small, lamellary.

Distribution.—Fossil. Cretaceous: Europe.

Genus BRACHYMÆANDRINA, *Duncan.*

Syn. *Cœloria* (pars), Ehr.

Colony large, low, attached, but extending beyond fixed point, slightly convex above. Corallites in long series, mainly radiating from the centre. Wall between the series rudimentary, discontinuous, and consisting of series of knob-like projections. Upper surface of ridges with exsert septo-costæ, spined and dentate, the upper wall-projections being visible. Calicinal centres not distinct. Columella small, essential, and receiving trabeculæ from the septal ends, projecting as little processes between the septal ends. Septa stout, short, exsert, angular in outline. Endotheca well developed, and often extending between the discontinuous parts of the walls. Common plateau without a true wall, and with a strong folded epitheca, from which spring the septa and columella.

Distribution.—Recent. Red Sea, Mergui, Ascension.

Genus STELLORIA, *d'Orbigny, Note sur les Polyp. foss.* p. 9 (1849).

Colony massive. Corallites in series united by their walls,

producing ridges at the calicular surface; these are simple, and are arranged in a radiating manner, and commence and end at the centres of star-like areas. The series are narrow, and the calicinal centres are almost completely indistinct. Columella absent or rudimentary.

Distribution.—Fossil. Cretaceous: Europe and England.

III. Alliance SYMPHYLLIOIDA.

Fissiparous Astræidæ, with corallites in linear series with distinct calicinal centres. Walls united directly or by costæ, or only free to a certain extent. Septa dentate or spined or entire.

Tribe I. With dentated septa.
Tribe II. With entire septa.

I. Genus SYMPHYLLIA, Ed. & H.
Genus PHYLLOGYRA, Tomes.
Genus DIMORPHOPHYLLIA, Reuss.
Genus STIBASTRÆA, Etallon.
Genus LATIPHYLLIA, E. de From.
Genus MYCETOPHYLLIA, Ed. & H.
Genus ULOPHYLLIA, Ed. & H.
Genus TRIDACOPHYLLIA, Blainville.
Genus COLPOPHYLLIA, Ed. & H.
Genus SCAPOPHYLLIA, Ed. & H.
II. Genus PLEROGYRA, Ed. & H.
Genus PHYSOGYRA, Quelch.
Genus PHYTOGYRA, d'Orb.

The genera ISOPHYLLIA, Ed. & H., and GYROSMILIA, Ed. & H., are absorbed.

Tribe I.

Genus SYMPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 369 (1857).

Syn. *Isophyllia,* Ed. & H.

The colony is massive, convex above or subplane. The corallites are in short or long linear series, which are united by their walls completely, or having a slight groove between them, or united below by the walls and close to the surface by costæ and exotheca. Calicular centres distinct in the series. Columella spongy. Septa numerous, much spined. Collines stout, tall, may be furrowed on the top. Endotheca abundant.

The genus is divided into groups of species characterized by the amount of mural fusion. In one group the walls are so united that no groove is seen on the "collines" between the corallites. In the second there is a narrow groove there; and in the third

group the corallites are united below by their walls, and near the calices by costæ and exotheca.

Distribution.—Fossil. Jurassic: England. Eocene, Miocene: Europe.—*Recent.* Indian Ocean, New Holland, north of Caribbean Sea.

In thus limiting *Symphyllia*, the genus is differentiated from *Mussa.*

M. de Pourtalès has shown that the genus *Isophyllia*, Milne-Edwards & Jules Haime, Pol. foss. des Terr. paléoz. &c. p. 87 (1851), is not separable from *Symphyllia.* It really only differs in that the dentations of the septa are subequal instead of being larger near the calicular margin. The species of *Isophyllia* must therefore be considered to belong to the genus *Symphyllia.*

After due consideration, it appears that the coral named *Symphyllia Etheridgii*, nobis, Suppl. Brit. Foss. Corals, pt. 3, p. 19, pl. vi. figs. 5–8, Oolitic Corals (Pal. Soc. Lond.), is correctly placed within the genus *Symphyllia* and not in the following.

Genus PHYLLOGYRA, *Tomes, Quart. Journ. Geol. Soc.* 1882, vol. xxxviii. p. 430.

"The corallum has a more or less depressed and massive form, and is composed of a series of leaf-like expansions, proceeding laterally from a parent corallite, the curled-up margins of which unite and form sinuous cristiform ridges, the line of union of which is very distinct in the younger examples, but much less so in the older ones. Gemmations take place successively amongst the elongated septa (which must be regarded as costæ rather than septa), and generally towards the extremity of the leaf, and a more or less distinct line of calices is produced. There appears to be no intercalicular gemmation. . . . When lateral gemmation has ceased, the corallum only increases in height by the growth of the single or serial corallites upwards. There is a common basal wall, which is either naked or costulate, or has bands of rudimentary epitheca. It is by the folding inwards of this outer wall, and not by the growth of inner walls, as in *Isastræa* and *Latimæandra*, that the sinuous ridges are formed."

Distribution.—Fossil. Oolite: England.

This genus, according to its author, contains some remarkable anomalies. A study of the figures given (*op. cit.* pl. xviii. figs. 5–7) of a species shows its eminently Symphyllian aspect, and the visible calices are the result of fissiparity. I introduce the genus here with doubt as to its value. Portions of a colony only have been found.

Genus Dimorphophyllia, *Reuss*, "*Foss. Foram., Anthozoen von Oberburg in Steiermark*," *Denks. d. Kais. Akad. der Wiss. Wien*, Bd. xxiii. p. 16, *altered*.

Colony low, narrowly pedunculate, thin, with an undulating margin. A central calice, with numerous septa which are confluent with those of other calices in eccentric circles; short or long, straight or curved ridge-shaped elevations pass from the margin of the colony, and are marked with costæ. The ridges enclose valleys with the eccentric calices, which do not appear to have columellæ. Costæ distinct.

Distribution.—Fossil. Jurassic, Eocene: Europe.

Genus Stibastræa, *Etallon*, *Etudes Pal. sur le Haut Jura*, 1858; *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 164.

Colony expanded, pedunculate. Calices disposed in series, more or less regular and long, around a central calice, directed to the circumference of the corallum. Series tolerably distant and united by their costæ. Septa thick and dentated. Columella papillary. Epitheca strong and folded.

Distribution.—Fossil. Jurassic: Europe.

Genus Latiphyllia, *E. de From. Introd. à l'étude des Polyp. foss.* p. 164 (1858–61).

Colony large, pedunculate, increasing fissiparously. Calices large, in series radiating from a central calice to the edge of the corallum, separate, and covered with epitheca. Columella absent. Septa large and distant. Costæ exist. Endotheca abundant.

Distribution.—Fossil. Jurassic: Europe.

Genus Mycetophyllia, *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. ii. p. 375 (1857).

The colony is massive and fixed. The corallites are united by their very thin walls. The calices are in series in valleys, which are shallow and more or less sinuous, the interseptal loculi being almost superficial; the calicinal centres are especially indicated by the direction of the septa, which are not numerous, barely exsert, wide apart, and strongly and unequally dentated. Columella rudimentary or absent. Endotheca vesicular and very abundant. Common plateau lobed, spinulose, and has a rudimentary epitheca.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Europe. Miocene: Europe.—*Recent.* Eastern seas.

Genus ULOPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 377 (1857).

Syn. *Oulophyllia*, Ed. & H.

Colony massive, convex, low, or subplane above. Corallites united by their walls completely, and presenting narrow ridges between the long sinuous valleys of the calices, which are not very distinct. Columella spongy and slightly developed. Septa close, slightly exsert, granulated laterally, and deeply incised at the edge with long sharp dentations, which are largest near the columella. The endotheca is well developed, and the interseptal loculi are deep. The common wall has a more or less complete epitheca.

Distribution.—Fossil. Jurassic, Cretaceous, Eocene, and Miocene: Europe.—*Recent.* Indian Ocean, Banda.

Genus TRIDACOPHYLLIA, *Blainville, Dict. des Sci. Nat.* t. lx. p. 327 (1830).

Colony tall, structures exceedingly thin. Corallites completely united by their very thin and often incomplete walls. Calicinal valleys subsinuous, long, broad, and very deep, separated by very thin, tall, irregular ridges. Calicinal centres fairly distinct. Columella absent or very rudimentary. Septa very narrow above, slightly exsert, not close, subequal, and dentated. The dentations are delicate, ascending and subequal; those near the centre of the calices are the largest. Common wall broken or festooned where free, with distinct, slightly projecting sinuous and spinose costæ. Dissepiments very oblique, convex, abundant, forming large vesicles; but the interseptal loculi are rather shallow.

Distribution.—Recent. American seas, Indian Ocean, Amboyna, Banda, China, Pacific.

Genus COLPOPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 383 (1857).

Colony massive, light and fragile, with a broad base, or pedunculate. Corallites united by their costæ, the walls never fusing at the calicular surface, where they are very slender. Calicinal valleys moderately long, flexuous, large, deep, with the calicinal centres more or less distinct. Columella rudimentary or none. Septa excessively thin, long, slightly exsert, and striated laterally; their free margin is delicately toothed and slightly excised near the middle. The common plateau has small lamellar costæ, broken up by dentations which are horizontal.

Distribution.—Recent. Caribbean Sea.

Genus Scapophyllia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 386, pl. 8. fig. 8 (1857); *Ann. des Sci. Nat.* t. x. sér. 3 (1849).

Colony massive, tall, cylindro-conical, erect, dense. Corallites united by their walls. Valleys short, very flexuous and shallow, and their calicular centres distinct. Occasionally simple calices present. Columella small, deep. Septa few in number, exsert, very echinulate laterally, the larger enlarged towards the columella, where the dentitions are the longest. Interseptal loculi deep. Dissepiments simple and wide apart. Collines variable in length, costulated, broad.

Distribution.—Recent. Chinese seas, Japan.

Tribe II.

Genus Plerogyra, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 468 (1848).

Syn. *Gyrosmilia*, Ed. & H.

The colony is composed of a series of long, thick, sinuous corallites, which unite more or less completely by their walls. The calicinal centres are moderately distinct. There is no columella. The entire septa are exsert, large, distant, nearly smooth, and often folded a little. The interseptal loculi are broad, almost superficial, or deep, and are closed below by large vesicular dissepiments. The costæ project but little, and disappear under a great development of mural vesicular tissue. Epitheca absent or rudimentary.

The genus may be divided into three groups of species :—

1. Species in which the walls are incompletely soldered.
2. Species in which the walls are completely united.
3. Species with subcristiform costæ, a rudimentary epitheca, and endotheca deep down in the interseptal loculi. This group includes the species of *Gyrosmilia*, Ed. & H., 1857, which is therefore absorbed.

Distribution.—Fossil. Cretaceous; Europe.—*Recent.* Singapore, Banda, East Indies, Red Sea.

Genus Physogyra, *Quelch, Ann. & Mag. Nat. Hist.* 1884, xiii. p. 293.

Corallum compound, form massive, of very light structure, having the calicles in long, sinuous, more or less meandroid

series, with their walls fused throughout, so as to form a simple, very thin line of separation between the series. Calicinal centres generally distinct, indicated by the curving of the septa. Costæ almost entirely absent. Epitheca very slightly developed. Septa thin, fragile, very prominent, distant, edge entire. Columella absent. Endotheca well developed, vesicular; the dissepiments continuous between the septa from the centre of the calicle to the wall, very convex above, rather far apart above each other, thus forming wide interseptal chambers. Owing to this great development of vesicular endotheca, the series of calicinal centres are separated by wide ridges formed entirely by the thin wall and by the convex dissepiments which stretch from the centre to this thin wall.

Distribution.—Recent. Banda.

Genus PHYTOGYRA, *d'Orbigny, Note sur les Polyp. foss.* p. 6 (1849); *Cours Elément. de Pal.* t. ii. p. 163, fig. 301 (1852).

Colony formed of rather thick, low, horizontal branches, free at the sides and below, composed of series of short corallites, whose calicinal centres are indistinct, and whose wall is naked and costulate. The columella is lamellar and continuous. The septa are entire and unequal, large. Increase by fissiparity.

Distribution.—Fossil. Jurassic: Europe.

D'Orbigny considers this genus to be a *Plerogyra* from its large alternate septa, but it has a lamellar columella. The figure given by him shows a trifurcate branch.

IV. Alliance MONTICULOIDA.

Astræidæ with fissiparous and serial corallites, united by their walls, which form prominent collines radiating more or less, or monticules marked by costæ.

Genus ASPIDISCUS, Kœnig.
Genus HYDNOPHORA, Ed. & H.
Genus MONTICULASTRÆA, Duncan.

Genus ASPIDISCUS, *Kœnig*, 1825; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 386 (1857), *amended.*

Colony subhemispherical, free. Under surface concave, and marked by a well-developed concentrically folded epitheca. Series of corallites radiating from a short, straight, polar colline to above the margin of the base; some series long, others between them

shorter. Corallites united by their walls, which form superficial, convex, radiating collines, with the septo-costæ on their flanks, and crossing over the top, which is a semiridge. Septa denticulate, not in distinct cycles, close, small, moderately unequal. Calices indistinct. Columella absent. Costæ bound the margin of the base superiorly, being directed radially.

Distribution.—Fossil. Cretaceous: North Africa, Europe?

Genus HYDNOPHORA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 419 (1857).

Colony massive and largely adherent. Corallites in series, united by their walls; their surface-ridges are simple, stout, compact, and their continuity is frequently, and often regularly, interrupted, giving an appearance of monticules separated by longitudinal and transverse valleys. Monticules marked with prominent costæ. Calicinal centres indistinct. Columella absent. Septa barely exsert, thin, rather close, denticulated, meeting those of the opposite side of the series at their inner end, which is slightly enlarged and bifurcate. Dentations strongest near the axis of the valleys. Interseptal loculi rather deep. Endotheca simple, nearly transverse.

Distribution.—Fossil. Cretaceous, Eocene, and Miocene: Europe. Eocene, Miocene: Asia.—*Recent.* Red Sea, Indian Ocean, Pacific.

Genus MONTICULASTRÆA, *Duncan, Fossil Corals and Alcyonaria of Sind, Pal. Ind.* Ser. xiv. p. 87 (1880).

Colony massive or foliated, sometimes pedunculate, irregular at its upper surface, and the base is covered with crowded radiating costæ. Collines small, short or long, often very irregular and costulate. Columella continuous around the collines, lamellar, separating the septal ends. Endotheca highly developed.

Distribution.—Fossil. Miocene: Sind, Asia.

6. Subfamily *Astræidæ agglomeratæ fissiparantes.*

Faviaceæ (pars), Milne-Edwards & Jules Haime, Hist. Nat. des Corall. vol. ii. p. 426 (1857).

Astræidæ forming massive or incrusting colonies. Corallites increasing by fissiparity, and sometimes by gemmation also, united by costæ or cœnenchyma, or both, or by the walls only, not forming long series, or non-serial.

Milne-Edwards and Jules Haime formed a subgroup of compound or colonial corals, which they placed between the Astræidæ which multiply by successive fissiparity and those which increase by gemmation only, the corallites in both instances being united by their walls or by intermediate structures. This group, the Faviaceæ, has genera the individuals of whose species increase by fissiparous division, and do not form series or have meandroid calices, but grow upwards independently so soon as to give the appearance of budding having taken place. The septa are always dentated and not entire. Now this group has greater affinities with the fissiparous Astræidæ than with those which increase by budding, and, moreover, a critical examination of its genera shows that it is not homogeneous.

The genus *Mæandrastræa*, d'Orb., clearly belongs to the alliance in which *Cœloria*, *Mæandrina*, and *Leptoria* are placed, and it has been noticed therein.

The genus *Favia*, Oken, with its intermural cœnenchyma and fissiparous and almost serial calices, is an ally of *Dichocœnia*, the distinction of the septal-edge structure being insufficient to separate the genera into subfamilies.

On the other hand, *Goniastræa*, *Septastræa*, and *Aphrastræa* should form an alliance, and be placed amongst the fissiparous Astræidæ.

Eighteen genera are recorded, but only thirteen remain after revision.

Alliances:—Favioida, Goniastræoida.

I. Alliance FAVIOIDA.

Massive fissiparous Astræidæ. Corallites united by costæ and cœnenchyma. Calices projecting but slightly or not at all above the common surface. Series very short, or only due to imperfect separation of the fissiparity. Septa entire or not.

Tribe I. Septa entire.
,, II. Septa dentated.

I. Genus DICHOCŒNIA, Ed. & H.
Genus BARYSMILIA, Ed. & H.
Genus STENOSMILIA, E. de From.

II. Genus FAVIA, Oken.
Genus FAVOIDEA, Reuss.
Genus BARYPHYLLIA, E. de From.
Genus SPINELLIA, D'Achiardi.

Genus PHYLLASTRÆA, E. de From.
Genus D'ACHIARDIA, Duncan.
Genera absorbed:—

FISCICELLA, Dana; OVALASTRÆA, d'Orb.; ELLIPSOCŒNIA, d'Orb.; THALAMOCŒNIA, d'Orb.; PARASTRÆA, Ed. & H.

Tribe I.

Genus DICHOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 199 (1857).

The colony is massive, pedunculate, hemispherical, lobed, or plane, and the large upper surface presents numerous low calices, some circular in outline, others united in short series. Columella small, sublamellar, or subpapillary. Septa well developed, entire, usually exsert. Pali before most of the septa. Costæ rather large, spinulose, and merging into the granular, dense, and highly developed intercalicular cœnenchyma, and they are seen to the base. Epitheca rudimentary. Endotheca exists. Increase by fissiparity and upward growth, accompanied by cœnenchymal development.

Distribution.—Fossil. Miocene: West Indies.—*Recent.* East and West Indies.

Genus BARYSMILIA, *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 468 (1848), *amended.*

The colony consists of a basal peduncle, or stout, tall trunk, on the top of which are variable numbers of corallites, separated by a cœnenchyma which consists of layers of mural and costal growth. Calices slightly projecting, free, in more or less transverse, straight, and parallel series; they are subelliptical in shape, and the long axis is perpendicular to the direction of the series. Columella rudimentary or absent. Septa close and slightly exsert, entire. Costæ visible from the base and largest near the calices. Epitheca absent. Endotheca present. Increase by fissiparity and upward growth.

Distribution.—Fossil. Cretaceous: Europe. Miocene: West Indies.

Genus STENOSMILIA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 383 (1870).

Colony massive, pedunculate, large, and convex above. Calices oval, often serial and unsymmetrical, distant, free to a slight

extent. Columella lamellary. Septa non-exsert, irregular, entire. Costæ visible near the calices and over the common wall of the peduncle. Peduncle growing by accumulation of layers of cœnenchyma, by which the corallites are separated. Endotheca exists. Increase by fissiparity.

Distribution.—Fossil. Cretaceous: Europe.

Tribe II.

Genus Favia, *Oken, Lehrb. der Naturg.* t. i. p. 67 (1813), *amended*; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 426 (1857).

Syn. *Fiscicella*, Dana; *Ovalastræa*, d'Orb.; *Ellipsocœnia*, d'Orb.; *Thalamocœnia*, d'Orb.; *Parastræa*, Ed. & H.

Colony hemispherical, convex, lobed, rarely subplane, fixed, free or incrusting. Corallites united by their costæ and by a cellular exotheca. Calices variable in distance, with free margins, subcircular, oval, deformed in outline. The columella is spongy. The septa are exsert, cross the wall, and the septo-costæ unite with those of other calices, or are separated by a groove. The septa are dentate, and the inner teeth simulate pali. Endotheca well developed. Epitheca often exists. Increase by fissiparity, the resulting corallites soon becoming separate.

Distribution.—Fossil. Jurassic: Europe, England. Cretaceous: Europe, England. Eocene and Miocene: Europe.—*Recent.* Atlantic, Caribbean, Red Sea, Indian Ocean, Pacific, Australian seas.

Genus Favoidea, *Reuss, Foss. Korall. von der Insel Java, 'Novara' Expedition*, p. 168.

Colony gibbous or flat on the free surface, massive. Calices rather distant and irregular in shape, shallow. Columella absent. Septa not numerous, unequal, spinulose, and usually thin; they extend beyond the calicular margin as costæ, and gradually merge into the cœnenchymal surface, not uniting with those of other calices. A cellular exotheca between the corallites. Endotheca exists. Increase by fissiparity of the corallites at the calices.

Distribution.—Fossil. Tertiary of Java; and Miocene, West Indies.

Genus Baryphyllia, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 139 (1858–60).

Colony having a tall trunk, on the top of which the corallites

are free only for a small space. Wall naked, and covered with granular costæ. The trunk grows by the superposition of layers derived from the costæ of the corallites. Columella none. Septa slightly exsert, and regularly dentate.

Distribution.—Fossil. Jurassic and Cretaceous: Europe.

This genus corresponds to *Barysmilia*, but has dentate septa.

Genus SPINELLIA, *d'Achiardi*, "*Corall. foss. dell' alpi Veneti*," *Mem. della Soc. Italia di sci. nat.* tom. iv. no. 1, pt. 2, p. 16 (Milan, 1868).

Colony in the form of a pedunculate lamina, attached, upper surface slightly convex. Corallites in long or short series, sometimes flexuous, not united by their walls above. Columella absent. Calicular centres distinct. Epitheca well developed. Intercorallite cœnenchyma developed and uniting the corallites.

Distribution.—Fossil. Eocene: Europe.

Genus PHYLLASTRÆA (*non Dana*), *E. de Fromentel, Pal. Franç., Terr. crét.* p. 483 (1879).

Colony tall, in the form of dendroid tufts. Corallites united together by a well-developed exotheca. Calices oval, often deformed by fissiparity. Columella lamellar and short. Septa large, in six cycles, and continued beyond the calices as short costæ, which lose themselves in a granular cœnenchyma, which fills the intercalicinal spaces.

Distribution.—Fossil. Cretaceous: Europe.

Genus D'ACHIARDIA, *Duncan, Fossil Corals and Alcyonaria of Sind, Pal. Ind.* ser. xiv. p. 92 (1880).

Colony large, massive, cylindrical or lobate. Corallites separated by a dense cœnenchyma, which is granulate or semilamellar at the surface. Calices separate, circular or deformed, rising slightly above the cœnenchyma, shallow. Columella flat, variable in development, papillary or not. Septa alternately large and small, barely exsert, dentated. Pali small and before the large septa. Costæ rudimentary on the calices, not found over the cœnenchyma, but occasionally existing on the flanks of the colony. Cœnenchyma cellular, dense. Endotheca exists. Increase by extracalicular gemmation and sometimes by fissiparity.

Distribution.—Fossil. Miocene: Sind, Asia.

II. Alliance GONIASTRÆOIDA.

Massive fissiparous Astræidæ. Corallites united by their walls, without cœnenchyma, not forming serial calices. Septa dentated.

Genus GONIASTRÆA, Ed. & H.
Genus LAMELLASTRÆA, Duncan.
Genus APHRASTRÆA, Ed. & H.
Genus SEPTASTRÆA, d'Orb.

Genus GONIASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 444 (1857).

Colony massive, convex or lobed, dense. Corallites prismatic, and intimately united by their walls, which are simple, compact, and thick. Calices polygonal, rather deep. Columella spongy. Septa rather exsert, denticulate. Pali before all the septa, except those of the last cycle, denticulate. Endotheca abundant. Common plateau covered by a thin and complete epitheca. Increase by fissiparity and also by gemmation.

Distribution.—Fossil. Cretaceous: Europe. Tertiary.—*Recent.* Red Sea, Indian Ocean, North-Australian seas, Pacific.

Genus LAMELLASTRÆA, *Duncan, Quarterly Journal of the Geological Society* ("*Fossil Corals of the West-India Islands*"), vol. xxiii. p. 19, pl. i. figs. 2 *a*, 2 *b* (1867).

Colony massive. Corallites united by their walls, and polygonal in transverse outline. Calices polygonal. Columella essential and lamellar, stout. Septa unequal, dentated. Pali absent. Endotheca scanty. Reproduction by fissiparity through the columella, a portion of it remaining as a large septum; also by marginal gemmation.

Distribution.—Fossil. Miocene: West Indies.

Genus APHRASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 451 (1857).

Colony convex and very light and cellular. Calices with simple margins, polygonal. Walls very thick, but entirely vesicular. Columella spongy. Septa exsert, dentate, with pali or paliform lobes before all the cycles of septa except the last. Endotheca vesicular and very developed. Increase by fissiparity. Common plateau with a complete epitheca.

Distribution.—Recent. Indian Ocean.

Genus SEPTASTRÆA, *d'Orbigny*, *Note sur les Polyp. foss.* p. 9 (1849).

Colony massive, subplane, convex or subdendroid. Corallites united by their walls. Calices polygonal, and their margins soldered to those of their neighbours, forming simple ridges, or showing a delicate furrow of separation. Septa large. Columella rudimentary or absent. Pali absent. Fissiparity of calices.

Distribution.—*Fossil.* Lias: England, Europe. Eocene: Europe. Miocene: America, Europe.

CHAPTER IV.

Subfamily ASTRÆIDÆ AGGLOMERATÆ GEMMANTES. Alliances. Genera.

7. Subfamily *Astræidæ agglomeratæ gemmantes.*

Syn. *Stylinaceæ agglomeratæ*, Ed. & H.; *Astræaceæ*, Ed. & H.; *Merulinaceæ*, Ed. & H.; *Echinoporidæ* (pars), Ed. & H.: combined.

Massive and foliaceous colonies. Corallites increasing by gemmation from the wall, from within the calice, and from intercorallite tissue. Corallites joined by costæ, exotheca, or peritheca, or fused by their walls. Septa entire or dentated. Endotheca vesicular, rarely tabulate.

The Agglomerate Stylinæ of Milne-Edwards and Jules Haime (*op. cit.* vol. ii. p. 232) were separated from their Astræaceæ, or massive budding Astræidæ, because these last had dentate septa.

In joining these groups into a subfamily no violence is done. As a subfamily the genera collect very naturally into two groups of Alliances. In one the corallites are separate, by their walls being united by costæ, exotheca, or peritheca; and in the other the walls are fused entirely, sometimes not joined at the calicular surface.

Alliance I. ORBICELLOIDA.
„ II. PLACOCŒNIOIDA.
„ III. STYLINOIDA.
„ IV. PHYLLOCŒNIOIDA.
„ V. CYATHOPHORIDA.
„ VI. PENTACŒNIOIDA.
„ VII. ELASMOCŒNIOIDA.
„ VIII. ECHINOPOROIDA.

Group-Genus GALAXEA, Oken.
„ LEPTASTRÆA, Ed. & H.

Alliance IX. BARYSASTRÆOIDA.
„ X. ASTROCŒNIOIDA.
„ XI. ISASTRÆOIDA.
„ XII. LATIMÆANDROIDA.
Group-Genus MERULINA.
Alliance XIII. PLERASTRÆOIDA.
„ XIV. TABULOIDA.
Group-Genus MOSELEYA.
„ DICTYOPHYLLIA.

Sixty-eight genera are recorded, but revision admits of fifty-five only.

I. Alliance ORBICELLOIDA.

Massive budding Astræidæ, with the corallites united by costæ, exotheca or intermediate tissue. Columella spongy or papillary. Septa dentated. With or without pali.

Genus HELIASTRÆA, Ed. & H.
Subgenus ULASTRÆA, Ed. & H.
Genus BRACHYPHYLLIA, Reuss.
Genus CYATHOMORPHA, Reuss.
Genus SOLENASTRÆA, Ed. & H.
Subgenus CYPHASTRÆA, Ed. & H.
Genus PHYMASTRÆA, Ed. & H.
Genus PLESIASTRÆA, Ed. & H.
Genus ANTILLASTRÆA, Duncan.

Genera *Ulastræa*, Ed. & H., and *Cyphastræa*, Ed. & H., become subgenera.

The genera AGATHIPHYLLIA, Reuss, and AMPHIASTRÆA, Etallon, are absorbed.

Genus HELIASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 456 (1857).

Colony of various shapes, convex, subspherical, subplane, short or tall, adherent, incrusting, or free. Corallites united by continuation of the exotheca, which exists between and beyond the costæ beneath the surface, rarely by the costæ themselves. Walls usually, but not invariably, stout. Calices with free circular margins, more or less cratériform and elevated. Columella well developed, spongy, and not projecting, with a plane free surface. Septa exsert or not, with well-developed laminæ, thicker near the margins than near the columella, where there is often a paliform tooth, dentate. Costæ well developed, passing over the surface for some distance; where seen on the wall of a corallite,

they are lamellar and well developed, often spiny. Endotheca well developed. Exotheca between and usually beyond the costæ, well developed. Epitheca may or may not exist. Gemmation inframarginal, and from the area between the calices.

Distribution.—Fossil. Oolitic, Cretaceous, Eocene: Europe, India, Borneo. Miocene, Pliocene: Europe, Asia, West Indies. —*Recent.* Red Sea, Indian Ocean, Pacific, Caribbean Sea.

Subgenus ULASTRÆA, (genus) *Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. x. pl. 9. fig. 4, et t. xii. p. 116 (1850).

This genus has but one species, which has all the characters of *Heliastræa*, and its septa and costæ are exceedingly echinulate. The species is *Orbicella crispata*, Dana,=*Ulastræa crispata*, Ed. & H., and these are now the synonyms of *Heliastræa crispata*, Dana, sp. The species is recent, and from the Indian Ocean.

Genus BRACHYPHYLLIA, *Reuss, Denksch. der Wien. Akad. der Wiss.* t. vii. p. 103 (1854); *M.-Ed. & Jules Haime, Hist. Nat. des Corall.* t. ii. p. 479 (1857).

Colony massive, short, convex, or subplane, fixed by a large base. Corallites large, united by their well-developed costæ. Calices projecting above a common surface, which is formed of much exotheca; and the costæ, large, separate, shallow, circular in outline. Columella well developed and spongy, or small and papillary where free. Septa numerous and regularly crenulated. Costæ well developed, crenulated, confluent. Endotheca and exotheca well developed. Epitheca absent. Gemmation lateral and subbasilar, the colony increasing at its circumference.

Distribution.—Fossil. Cretaceous, Eocene: Europe. Miocene: West Indies, Trinidad.

Genus CYATHOMORPHA, *Reuss, "Pal. Stud. über die ält. tertiärsch. der Alpen," Denks. der K. Akad. der Wiss. Wien,* 1869, p. 243, and indefinitely, 1868, p. 14.

Syn. *Agathiphyllia*, Reuss.

Colony increasing by extracalicular budding, massive. Calices circular or broadly elliptical, projecting, well separated, margins rounded. Fossa large, shallow; columellary area circular and deeper than rest of fossula. Columella papillary, not projecting. Septa numerous, close; primaries and secondaries with an inner and outer paliform lobe; tertiaries with the same in a modified

degree. Costæ continuous with the septa, passing over the outer surface of the wall, rarely confluent. A marked depression between the corallites. Endotheca exists. Epitheca often in bands. The young colony consists of a few corallites comparatively without union, except by the base of the beds.

Distribution.—Fossil. Eocene: Europe.

This genus supersedes *Agathiphyllia*, Reuss.

Genus PHYMASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 499 (1857), *amended*; *Duncan, Proc. Zool. Soc.* 1883, p. 408 (June 19).

Syn. *Amphiastræa*, Etallon.

Colony massive, tall or very short, with a convex or plane free surface. Corallites more or less prismatic, increase by extracalicular gemmation, and are joined together by short growths from costæ or from the wall, which are placed with some regularity in vertical series; elsewhere they are separate. An epitheca exists, which may environ the growths. Calices separate, unsymmetrical. Columella present. Septa variable in number, dentated. Costæ may or may not be apparent.

Distribution.—Fossil. Jura: Europe.—*Recent.* Indian Ocean; Mergui.

M. Etallon described the genus *Amphiastræa* in 1858, and M. de Fromentel introduced it in his 'Introd. à l'étude des Polyp. foss.;' but neither had studied the recent fauna; had they done so they would have found their fossil form to be of the same genus as *Phymastræa*, Ed. & H., 1848. *Amphiastræa* is absorbed.

Klunzinger, in his excellent work on the Corals of the Red Sea, unites the genera *Cyphastræa* and *Solenastræa* of Milne-Edwards and Jules Haime. *Cyphastræa*, Ed. & H., has all the characters of *Solenastræa*, and in addition the septal laminæ are perforate, trabeculate, and cribriform, except close to the wall, where they are solid. Some modern Solenastræans have this character, and hence the proposed union. The fossil *Cyphastræa costata*, nobis, of the West-Indian Miocene has exceedingly cribriform septa, so that the distinction is not modern. The character has nothing to do with fossilization or with wearing, and it is general over the whole of the corallites of the species. But some fossil Solenastræans have solid, non-cribriform septa. There is not a generic distinction between the two forms; but *Cyphastræa*, which is more recent than *Solenastræa*, had better become a subgenus.

Genus SOLENASTRÆA, *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. ii. p. 495 (1857), *altered*.

Colony massive but light, convex above, incrusting or tall, often gibbous, rarely plane. Corallites long or short, united by a well-developed exotheca, which extends beyond the small costæ. Calices with free margins, which are usually circular, but sometimes unsymmetrical in outline. Columella spongy or feebly developed. Septa thin or stout, imperforate, dentate. Endotheca fairly developed. Gemmation extracalicinal.

Distribution.—*Fossil.* Eocene: Europe, Borneo. Oligocene: England. Miocene: Europe and West Indies. Crag: England (?).—*Subfossil.* Red Sea.—*Recent.* Red Sea, Indian Ocean, Singapore, Caribbean Sea.

Subgenus CYPHASTRÆA, (genus) *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. ii. p. 484 (1857).

The generic characters are as in *Solenastræa*, but the septa are cribriform.

All so-called Solenastræans with cribriform septa must enter this subgenus, and all the recorded species of the genus, according to Milne-Edwards and Jules Haime.

Distribution.—*Fossil.* Miocene: West Indies.—*Recent.* Red Sea, Caribbean Sea, Pacific, Australian seas.

Genus PLESIASTRÆA, *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. ii. p. 489, pl. D 7. fig. 5 (1857).

Colony variable in shape, massive, convex or subplane above, with a naked and costulate common wall. The corallites may have thick or thin walls, be close or distant, and in the first instance may fuse inferiorly, and in the last may have a feeble exotheca between them. Calices shallow, circular and free. Columella spongy. Septa well developed, exsert, denticulate near the calicular edge. Pali well developed and in contact with all the septa which precede those of the last cycle. Endotheca very feebly developed. Costæ and exotheca usually well developed. Epitheca absent. Gemmation occurs in the intercalicinal areas.

Distribution. — *Fossil.* Eocene: India (Sind). Miocene: Europe, Sind, Asia.—*Recent.* Pacific, North-Australian seas, Indian Ocean, Caribbean Sea.

In the Tertiary deposits of San Domingo are several species of *Plesiastræa*-looking corals (Duncan, "West-Indian Corals," Proc. Geol. Soc., Nov. 1863, p. 37 *et seq.* and pls. iv. & v.). There are

the usual attributes of *Plesiastræa* present, but the exotheca is in excess and there is an epitheca. The columella is papillary and more concentrated than is shown in the drawing (pl. iv. figs. 4*a* & 5).

This group includes *Plesiastræa distans*, *P. globosa*, and *P. ranea*, nobis.

Another species, *Plesiastræa spongiformis*, Duncan, *op. cit.* p. 39, pl. iv. figs. 6 *a*, 6 *b*, requires a new generic environment.

Genus Antillastræa, gen. nov.

Colony very convex above, pedunculate and attached. Calices close, barely projecting; fossula shallow. Columella cylindrical and flattened in young, styliform in old calices. Septa subequal, few, well developed. Pali before all cycles except the last. Costæ subequal, projecting, ending in exotheca, which is cellular and well developed. Endotheca scanty. Epitheca rudimentary.

Distribution.—Fossil. Miocene: San Domingo.

II. Alliance PLACOCŒNIOIDA.

Massive budding Astræidæ, with corallites united by costæ or by exotheca. Septa entire. Columella lamellary, or a septum reaches the axial space.

Genus Placocœnia, d'Orb.
Genus Placophora, E. de From.
Genus Pleurostylina, E. de From.

Genus Placocœnia, *d'Orbigny*, *Note sur les Polyp. foss.* p. 7 (1849); *Goldfuss*, *Petr. Germ.* pl. 24. fig. 2.

Colony massive. Calices large, circular, or oval, rather distant, united by costæ. Columella lamellar and well developed, or in three papillæ. Septa entire, unequal, of the decameral or of hexameral type. Costæ thick and well developed, cristiform or granular. Gemmation between the calices.

Distribution.—Fossil. Oolite and Cretaceous: Europe.

Genus Placophora, *E. de Fromentel*, *Pal. Franç.*, *Zooph. Terr. crét.* p. 495 (1879).

Colony expanded, with a subplane surface formed by close laminæ, slightly granular on the surface, on which the calices are free to a slight extent. Calices round or slightly oval, distant (5–8 mm.). Columella large, lamellar. Septa well developed

and slightly undulating (entire ?). There are 36 septa, unequal according to cycles.

Distribution.—Fossil. Cretaceous : Europe.

Genus PLEUROSTYLINA, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 201 (1858–61).

Colony in a convex mass or in extended laminæ. Calices circular or polygonal in places. Septa entire, few; one large septum reaches the centre of the calice and swells there, after the fashion of a columella. Corallites united by their walls or by epitheca, which covers the walls. Common plateau naked and costulate, or presenting a slightly developed epitheca.

Distribution.—Fossil. Oolite: Europe.

There is much that is unsatisfactory about this genus. The epitheca uniting the corallites and not covering the "plateau commun" is difficult to understand. Perhaps the author of the genus meant exotheca uniting the corallites.

III. Alliance STYLINOIDA.

Massive budding Astræidæ, with corallites united by their costæ or by exotheca. Columella styliform. Septa entire and dentated. Pali may be present or not.

Tribe I. With entire septa.

Genus STYLINA, Lmk.

Genus PSAMMOCŒNIA, Ed. & H.

Tribe II. With dentate septa.

Genus COLUMNASTRÆA, Ed. & H.

Genus STYLASTRÆA, E. de From.

HELIOCŒNIA, Etallon, appears to be a subgenus of *Stylina.*

Tribe I.

Genus STYLINA, *Lamarck*, 1816; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 233, *amended.*

Colony in the form of subplane, convex, gibbous masses, or dendroid. The corallites are united by their costæ and well-developed exotheca, or only here and there, and terminate at the free surface in little conical elevations more or less projecting. The calices on these elevations are for the most part circular, free at their margins, and usually distant. The columella is styliform and projects. The septa are exsert, well developed,

and numerous or few. Occasionally some primaries are larger than others. Cycles hexameral, or octameral, or decameral. The walls are thick. Costæ well developed. The endothecal dissepiments are simple or subvesicular. Gemmation is from the wall outside of the calice and from the intercalicular space.

Distribution.—Fossil. Trias: Europe. Oolite: England and Europe. Cretaceous: Europe.

Heliocœnia, Etallon (genus), appears to differ from *Stylina* in having costæ which do not extend far from the calicular margins. The columella is sometimes a little compressed. These are hardly generic distinctions, and I propose to consider *Heliocœnia* as a subgenus.

Genus Psammocœnia, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 285 (1857).

Colony massive. Corallites separated by exotheca. Calices unequally close and irregularly projecting, small. Columella styliform. Septa divided into six simple systems and there are six pali. Intercalicular area granular, and hardly striated with costæ.

Distribution.—Fossil. Ligsdorf (Haut Rhin), Europe.

Tribe II.

Genus Columnastræa, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 262 (1857). Illustrated by Reuss, Denkschr. der Wien. Akad. der Wiss. t. vii. pl. 14. figs. 1 & 2 (1854), and Duncan, "West-Indian Corals," Proc. Geol. Soc., Dec. 1867, pl. v. figs. 1 *a* & 1 *b* (by error the word "stoloniform" was printed for "styliform," p. 18).

Colony massive, convex, lobed, or subdendroid. Corallites united by costæ. The calices are moderately deep, circular, and projecting, and have their margins free. The columella is styliform and not much developed. The septa are thin, arched where free, denticulate. There are pali which form a single crown. The costæ are well developed. The gemmation occurs from the intercorallite tissue.

Distribution.—Fossil. Cretaceous: Europe. Eocene: West Indies. Pliocene: Europe.

E. Pratz has shown that the septa of the species of this genus are not entire at the free edge.

The following genus is not satisfactory in the face of the possibility of *Stylina* having dentate septa:—

Genus STYLASTRÆA, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 223 (1858–61).

Colony convex, massive. Corallites circular in outline and united by a considerable development of the costæ. Calices projecting, circular. Columella round, styliform, and well developed. Septa strongly and regularly dentated. Costæ well developed, and pass towards those of the neighbouring calices without being actually confluent. Gemmation between the calices.

Distribution.—Fossil. Cretaceous: Europe.

IV. Alliance PHYLLOCŒNIOIDA.

Massive budding Astræidæ. Corallites united by their costæ, with or without the intervention of exotheca. Columella absent. Endotheca vesicular or tabulate.

Tribe I. With entire septa.

Genus PHYLLOCŒNIA, Ed. & H.

Genus CONVEXASTRÆA, d'Orb.

Tribe II. With dentate septa.

Genus ADELASTRÆA, Reuss = CONFUSASTRÆA, Ed. & H.

Tribe I.

Genus PHYLLOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 272, 1857 (*non Laube*), *amended.*

Colony convex, subspherical, with a large base, or pedunculate, or subplane. Corallites costulate and united by much exotheca, parallel or divergent. Calices circular or deformed, free at the margins, and projecting. Columella absent or rudimentary. Septa large, entire, exsert, and well developed. Costæ well developed, prominent, uniting calices. Endotheca abundant and often vesicular. Gemmation occurs between the calices.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Europe, Sind in Asia. Miocene: San Domingo.

The form described by Laube from St. Cassian is not of this genus. This is proved by the magnified view of the section. There is a double wall to the calice, one marginal and the other beyond. Neither is the form a species of *Cyathocœnia*, Duncan. It comes within the Elasmocœnioid alliance (see p. 115).

Genus CONVEXASTRÆA, *d'Orbigny, Note sur les Polyp. foss.* p. 9 (1849). Illustrated by Milne-Edwards & Jules Haime, Brit. Foss. Corals, Pal. Soc. pl. 23. figs. 5 & 6, and Hist. Nat. des Corall. vol. ii. p. 277 (1857).

Colony convex, gibbous, or dendroid. Corallites united by their well-developed costæ. The walls are cylindrical, and their calicinal margin is hidden by the septo-costæ, which are few in number, straight, exsert, and slightly granular. The septa are few in number, continuous with the costæ, and these last do not all reach from calice to calice, and there is often an intercalicular furrow. There is no columella.

Distribution.—Fossil. Trias: Europe. Oolite: England and Europe.

Tribe II.

Genus ADELASTRÆA, *Reuss, Denkschr. der Wien. Akad. der Wiss.* t. vii. p. 115 (1854), correcting the name *Confusastræa*, d'Orb.; and Milne-Edwards & Jules Haime, Pol. foss. des Terr. pal. p. 98 (1831).

Syn. *Confusastræa*, d'Orb.

Colony massive, with a plane or convex surface. Corallites intimately united by their costæ, which sometimes are confluent. Calices large and very slightly projecting, shallow, with margins rounded off, resembling circular bourrelets. Walls of calices rudimentary. Polygonal grooves between the calices indicating the junction of corallites. Septa well developed and uniting by their inner edges without the intervention of a columella.

Distribution.—Fossil. Trias: Europe. Oolite: Europe, England? Cretaceous: Europe.

The unclassical word *Confusastræa* was abolished by Reuss.

V. Alliance CYATHOPHOROIDA.

Massive Astræidæ, increasing by gemmation. Corallites separated by cœnenchyma or exotheca. Columella absent or present. Dissepiments or transverse tabulæ.

Genus CYATHOPHORA, Mich.
Genus AREACIS, Ed. & H.
Genus PSAMMOPHORA, E. de From.

Genus CYATHOPHORA, *Michelin, Icon. Zooph.* p. 104 (1843), *amended.*

Colony massive, convex. Corallites united by their costæ and

exotheca. Calices slightly projecting, circular, united by costæ. Columella absent. Septa unequal, but not numerous. Endothecal dissepiments stretching across the internal cavities of the corallites like tabulæ.

Distribution.—Fossil. Oolite: England, Europe. Cretaceous: Europe.

Genus Areacis, *Milne-Edwards & Jules Haime, Comptes Rend. de l'Acad. des Sci.* t. xxix. p. 70 (1849).

Colony massive and Astræiform. Calices circular or deformed, separated by cœnenchyma. Cœnenchyma spongy and echinulate on the surface. Walls of corallites distinct from the surrounding cœnenchyma. Septa unequal, entire, principal uniting in the axis. No columella. Endotheca rudimentary, or as well-developed horizontal tabuliform processes.

Distribution.—Fossil. Eocene: Europe, Borneo.

Genus Psammophora, *E. de Fromentel, Pal. Franç., Zooph. Terr. crét.* p. 494 (1879).

This genus was created for Stylophorinæ with a papillary columella, before such a thing was found. M. de Fromentel subsequently found a coral in the d'Orbigny museum which presented the characters of the Stylophorinæ and also a papillary columella.

The figures given (pl. 90. fig. 4) show a wretched specimen. However it has a compressed, thin, laminate form with calices on both sides. There are four cycles of septa and fine costæ. Calices wide apart.

It is not one of the Stylophorinæ, and I place it here with some doubt.

Distribution.—Fossil. Cretaceous: Europe.

VI. Alliance PENTACŒNIOIDA.

Agglomerate Astræidæ, increasing by gemmation. Corallites united by the costæ, more or less free above. Primary septa five in number.

Genus Pentacœnia, d'Orb.
Genus Acanthocœnia, d'Orb.

Genus Pentacœnia, *d'Orbigny, Rev. et Mag. de Zool.* p. 175 (1850).

Calices with their margins either subcircular and free, or poly-

gonal and united. Five principal septa. No columella. Calices from 1 to 2 millim. broad.

Distribution.—Fossil. Cretaceous (Neocomian): Europe.

Genus ACANTHOCŒNIA, *d'Orbigny, Rev. et Mag. de Zool.* p. 175 (1850).

Colony massive. Calices circular, with free margins and a styliform columella. Septa in three cycles, but there are only five primaries.

Distribution.—Fossil. Cretaceous (Neocomian): Europe.

VII. Alliance ELASMOCŒNIOIDA.

Agglomerate Astræidæ, increasing by gemmation between the calices. Corallites united by a second wall, with or without exothecal cœnenchyma.

Genus DIPLOCŒNIA, E. de From.
Genus DIPLOCŒNIASTRÆA, D'Achiardi.
Genus DIPLOTHECASTRÆA, Duncan.
Genus KOILOCŒNIA, Duncan.
Genus ANISOCŒNIA, Reuss.
Genus HETEROCŒNIA, Ed. & H.
Genus ELASMOCŒNIA, Ed. & H.

Genus DIPLOCŒNIA, *E. de Fromentel, Notes à l'étude des Polyp. foss.* p. 183 (1858–61); *Descrip. des Polyp. foss. de l'étage Néocom.* p. 39, pl. v. figs. 7, 8, 9 (1857).

Colony tall, or in a rounded mass. Corallites with two walls—one projecting and hidden by the septa, but indicated by a circular bourrelet; the other united to the walls of the neighbouring corallites separating the costæ, and variable in its outline. Columella styliform and strong. Septa entire, thick, and continuous with the costæ. Gemmation ?

Distribution.—Fossil. Oolite and Neocomian: Europe.

Genus DIPLOCŒNIASTRÆA, *D'Achiardi, Coralli Giurassici dell' Italia Settent.* (Pisa, 1880).

Colony in thick laminæ. Corallites immersed in the cœnenchyma, which is compact. Calices circular, filling up below. Columella small, spongy. Septa spinulose, straight, the larger joining the columella, continuous with costæ which occupy the outer calicular spaces, and merge into those of neighbouring calices. Gemmation peripheral.

Distribution.—Fossil. European Oolite.

D'Achiardi describes a single species from one specimen, which he considers the type of this genus, *Diplocœniastræa.* He considers that this genus, by having denticulate septa and a spongy columella, differs from *Diplocœnia.* Unfortunately the internal structures of M. d'Achiardi's specimen are not visible, notwithstanding the perfection of the superficial septa, costæ, and columella. The form is described in 'Coralli Giurassici dell' Italia Settentrionale,' Pisa 1881, p. 41. I introduce the genus into the Alliance with a little doubt.

Genus Diplothecastræa.

Syn. *Diplocœnia* (non E. de Fromentel), Duncan, West-Indian Corals, Quart. Journ. Geol. Soc. vol. xxiv. (1867), p. 20, pl. i. fig. 3.

The colony is massive. Corallites tall, crowded, polygonal, united by a well-developed common wall which projects at the calicular surface. Within the polygonal wall is a space occupied by cœnenchyma of oblique vesicular dissepiments, and within that an internal wall, whence arise the septa. This calicular wall is circular in transverse outline, wavy and thin. Columella lamellar, and often joined to one of the septa. Septa wide apart, unequal; cycles imperfect. Endotheca slight, within the inner wall. Gemmation occurs from the cœnenchymal space.

Distribution.—Fossil. Miocene: West Indies.

Genus Koilocœnia, *Duncan.*

Syn. *Phyllocœnia,* Laube.

Colony convex or subplane above, massive, low. Corallites with an intermediate structure which is usually a second wall to each, and which may fuse with those of others. Here and there intermediate exotheca. Calices with well-developed costæ, which in section do not touch those of other calices. Septa well developed, but short. Axial space large, hollow, and without a columella.

Distribution.—Fossil. Trias (St. Cassian): Europe.

This genus is founded to receive *Phyllocœnia decipiens,* Laube. It is very well defined by the absence of columella, the short septa, and the double wall, as seen in sections. Mr. Tomes mistook the superficial view for *Cyathocœnia,* nobis, in a paper read before the Geological Society of London and not yet published.

Genus ANISOCŒNIA, *Reuss, Foss. Korallen von der Insel Java, 'Novara' Expedition*, p. 166.

Colony in stumpy or finger-shaped masses. Calices irregularly shaped and sized, surrounded by cœnenchyma, on which the margins are raised and often grooved. Columella none. Septa unequal, some very thick and others very thin, entire, non-exsert, feebly granular. Cœnenchyma cellular, apparently of exotheca forming the ends of feeble costæ. Endotheca well developed, oblique, and uniting the ends of the larger septa around the axial space. Gemmation extracalicular.

Distribution.—Fossil. Eocene: Java.

Genus HETEROCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 282 (1857). Illustrated by Reuss, Denkschr. der Wien. Akad. der Wiss. t. vii. pl. 10 (1854).

The colony is convex and gibbous, or dendroid. The corallites are united by an abundant cœnenchyma formed of mural expansions and exothecal dissepiments. The calices are distant, circular, and projecting. There is no columella. Septa exsert and well developed; but there are never more than 12, and often only 6, and they are unequal, there appearing to be three simple systems of them.

Distribution.—Fossil. Cretaceous: Europe.

Genus ELASMOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 279 (1857). Illustrated by Michelin, Icon. Zooph. pl. 51. fig. 3 (1845), as *Oculina explanata*.

Colony convex, more or less massive, or sublamellar. Corallites wide apart, and united by mural expansions which are granulated and feebly striated where free, and which are formed by layers of vesicular exotheca or cœnenchyma. The walls are thick; the septa are irregular and very granular. There is neither columella nor pali. Calices circular or subelliptical. Costæ feebly developed.

Distribution.—Fossil. Cretaceous: Europe.

VIII. Alliance ECHINOPOROIDA.

Massive, budding, rarely fissiparous Astræidæ, foliaceous. Corallites short, united by an echinulate cœnenchyma. Septa spinulose.

Genus ECHINOPORA (pars), Dana.
Genus ACANTHOPORA, Verrill.
Genus PHYSOPHYLLIA, Duncan.

Milne-Edwards and Jules Haime introduced a subfamily of Astræidæ to receive the genus *Echinopora*, Lamarck and Dana. Verrill has shown that this genus is not homogeneous, and that some species should be associated with the family Fungidæ, and one with the Astræidæ proper.

The following is the diagnosis of Dana as given by Milne-Edwards and Jules Haime, in whose work the early synonymy is given.

Genus Echinopora (*pars*), *Dana*, *Wilkes Exploring Expedition, Zoophytes*, p. 278 (1846).

The colony is thin, adhering in the middle, and extending on all sides in foliaceous laminæ which are ordinarily lobed. The common plateau is costulate radially, and has a rudimentary epitheca. Corallites very short and greatly spined, united by an echinulate cœnenchyma. The calicular margins have the shape of circular and more or less projecting bourrelets. The free edges of the septa are very spined, the strongest teeth being near the columella, where they frequently simulate pali. Columella spongy. Endotheca slightly developed.

Distribution.—Fossil. Miocene: Sind, Asia.—*Recent.* Indian Ocean, Indo-Pacific, Red Sea.—*Subfossil.* Red Sea.

This diagnosis still holds good for some species which should, however, enter the Astræidæ.

But *Echinopora aspera*, Ellis & Solander, has been shown by Verrill to belong to the Fungidæ; and he has established the genus *Trachypora* for it. It appears that this name had been already applied to other forms before Verrill gave it; and Klunzinger suggests the name *Echinophyllia* instead. *Echinopora horrida*, Dana, which Milne-Edwards and Jules Haime state to be a dendroid variety of *Echinopora hirsutissima*, Ed. & H., 1850, has been made the type of the genus *Acanthopora*, Verrill, because its polyps differ from those of other *Echinoporæ*, and because the calices become filled up as in *Oculina*.

Genus Acanthopora, *Verrill*, *Bull. Mus. Comp. Zool. Camb. Mass.* 1864, No. 3, p. 54.

Colony ramose, solid, the cells being filled as in *Oculina*. Costæ represented by series of spines.

This short diagnosis hardly suffices. The corallites are short, having the shape of large and strongly spined button-shaped prominences. Costæ very thick, subequal, separated by deep

spaces in which there may be small costæ. Very spinulose. Calicular fossa moderately deep. Columella subpapillary. Septa exsert, with the free edge very incised. Steroplasma filling much of the calice with age.

Distribution.—Recent. Indian Ocean.

Genus PHYSOPHYLLIA.

Colony large, spreading, pedunculate, foliaceous, folia united and presenting faint broad ridges, which are crossed by septocostæ. Corallites low, wide apart, arranged more or less in concentric circles. Calices distant, large, sunken, deep, elongate, forming series of 2 to 4, or circular. Fossa large and deep. Columella small, trabeculate. Septa large, exsert, spinulose, especially near the axis, unequal, wide apart; ending in septocostæ which are confluent with those of the calices on either side, and some of which pass over broad ridges radially. Intercalicular surface large, gibbous or ridged, formed of convex vesicular endotheca; this endotheca fills up the interseptal loculi also, and is greatly developed. Calices on one side of the colony only. Common wall inferior, costulate to the base. Costæ distinct, spinulose. No epitheca. Fissiparity occurs, and also gemmation.

Distribution.—Recent. Locality?

There is but one specimen in the British Museum of this genus, but it is a very marked form. The late Mr. Brüggemann gave the form a manuscript name, but did not describe it. The classificatory position is doubtful, but I place it here.

GROUP. Massive budding Astræidæ. Corallites united by peritheca.

Genus GALAXEA, *Oken* (1815); *amended in Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 223 (1857).

Colony fasciculate and submassive. Corallites elongate, with stout walls marked with feeble costæ. Calices circular or deformed. Columella absent or rudimentary. Septa usually very exsert, lanceolate, often slightly granular on their sides, entire. Endotheca moderately abundant. A peritheca or vesicular intercorallite growth is abundant, and joins the corallites and their ends together. It reaches up to different distances from the calicular margin, so that the upper ends of the corallites project above. Gemmation subbasilar and from the wall.

Distribution.—Recent. Red Sea, Indian Ocean, Pacific.—*Subfossil* in raised beaches.

Group-Genus Leptastræa.

Genus Leptastræa, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 493 (1857).

The colony is massive, or else incrusts, and is subplane or convex at the free surface. Corallites short, with very dense muro-costal structures, which become compact and fused. Calices with distinct margins, close, shallow. Columella papillary. Septa thin, close, exsert, margin subentire, granular; inner edge trabeculate, with ascending denticles. Costæ small, visible between the calices. Endotheca feeble. Gemmation extracalicular; sometimes fissiparity occurs.

Distribution.—Recent. Indian Ocean and Red Sea.

It appears that the incrusting species extends by a kind of stoloniferous gemmation.—*Duncan, Proc. Linn. Soc.* 1884.

IX. Alliance BARYSASTRÆOIDA.

Agglomerate Astræidæ, increasing by marginal and submarginal (within the calice) gemmation. Walls fused, but thick, and often subcellular. Septa denticulate.

Genus Barysastræa, Ed. & H.
Genus Acanthastræa, Ed. & H.

Genus Barysastræa, *Milne-Edwards and Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 312, pl. D 8. fig. 2 (1857).

The colony is convex or subgibbous, very dense and compact. The corallites are united by their very thick and solid walls. Calices shallow, close, small, polygonal, and barely separated by shallow grooves. Columella subpapillary above, compact and large low down. Septa very thick, close, and not much toothed. Endotheca slightly developed. Internal cavity gradually filling up inferiorly. Gemmation submarginal.

Distribution.—Recent. Locality ?

Genus Acanthastræa, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 501, pl. D 6. fig. 1 (1857).

The colony is in the shape of a subplane or convex mass. The corallites, short or tall and broad, are united by their walls which are subcellular. Calices subpolygonal, with broad spinous margins, with or without irregular superficial grooves. Columella parietal or rudimentary. Septa exsert, stout, and much spined, the largest of the spines being the most external. The upper part of the lamina is trabeculate below the spinous teeth. Endo-

theca greatly developed. Epitheca complete. Gemmation submarginal and marginal.

Distribution.—Subfossil. Red Sea.—*Recent.* Red Sea, Indian Ocean, Pacific.

X. Alliance ASTROCŒNIOIDA.

Agglomerate Astræidæ, increasing by extracalicular, marginal, and lateral gemmation. Columella variable. Pali may or may not exist. Corallites united by their walls, with sometimes a cœnenchymal development. Septa denticulate or entire.

Tribe I. With denticulate septa.
Genus ASTROCŒNIA, Ed. & H.
Genus CYATHOCŒNIA, Duncan.
Genus STEPHANOCŒNIA, Ed. & H.
Genus NARCISSASTRÆA, E. Pratz.

Tribe II. With entire septa.
Genus STYLOCŒNIA, Ed. & H.
Genus HALDONIA, Duncan.

Genera absorbed:—CŒNASTRÆA, Etallon; STEPHANASTRÆA, Etallon.

Genus described and not placed:—BATHYCŒNIA, Tomes, probably = STYLOCŒNIA.

Tribe I.

Genus ASTROCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 254, *amended.*

Syn. *Cœnastræa*, Etallon (1864).

Colony variable in shape, massive, gibbous, lamellar, dendroid or discoid, compact, sometimes incrusting. Corallites prismatic or cylindrical, uniting by their walls, which are thick and simple; cœnenchyma rare between them. The calices are polygonal, irregular or regular in shape and size, and their margins are ordinarily simple. The columella is styliform and more or less projecting. The septa are dentated minutely, few in number, and often irregular in their cyclical arrangement. Gemmation marginal and lateral, or marginal and circumferential only.

Distribution.—Fossil. Trias: Europe. Infra-Lias: England and Europe. Lias, Oolite: Europe, England? Cretaceous, Eocene: England and Europe, Asia. Eocene: Borneo. Miocene: Europe, West Indies; Sind, Asia.—*Recent.* Caribbean Sea.

Genus CYATHOCŒNIA, *Duncan, Brit. Foss. Corals* (*Zone of* Amm. angulatus), *Pal. Soc. Lond.* 1867, pt. iv. no. 1, p. 27.

Colony fasciculate or gibbous, or incrusting. Corallites

united by their walls and by more or less cœnenchyma, polygonal, and often cylindrical. Calices small. Columella absent. Septa finely dentate. Costæ not confluent. Gemmation superior and marginal.

Distribution.—Fossil. Infra-Lias: England.

The presence of structure between the walls is decided; but it is very slight, and not sufficient, considering the other characters, to remove the genus out of this Alliance. The nature of the calicinal walls and the irregular septal distribution of the genera *Aplocœnia* and *Pentacœnia* distinguish them from the above. The genus is distinct from *Koilocœnia*.

Genus STEPHANOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 264 (1857).

Syn. *Stephanastræa*, Etallon, 1864.

Colony massive, convex, lobed, or pedunculate, or incrusting or dendroid. Corallites united by their walls, which are compact and thick. Calices generally polygonal, with simple margins. The columella is styliform and slightly projecting, but always well developed. The septa are slightly exsert, denticulate slightly, well developed, granular at the sides. There are pali before all the septa except those of the last cycle. Gemmation marginal and lateral.

Distribution.—Fossil. Jurassic: Europe. Cretaceous: Europe and England. Eocene: Europe. Eocene and Miocene: Sind, Asia, West Indies.—*Recent.* Locality?

Genus NARCISSASTRÆA, *E. Pratz, Eocene Korallen aus der Libyschen Wüste und Aegypten* (1883), p. 228.

Colony massive, composed of long, polygonal corallites united by their walls, without costæ and cœnenchyma. Calices more or less deep. Septa toothed. Pali in one crown. Columella? Dissepiments abundant.

Distribution.—Fossil. Eocene: N.E. Africa.

The genus will be better understood when other types of it are found. It is allied to *Stephanocœnia*.

Tribe II.

Genus HALDONIA, *Duncan, Quart. Journ. Geol. Soc.* vol. xxxv. (1879), p. 91.

Colony massive, incrusting, convex above. Corallites united by their walls. Calices small, circular in outline, raised, deep, and widely open, separated by a slight depression. Columella

absent. Septa unequal, slender, not exsert, low vertically, entire. Pali just within the primaries, small, distinct, narrow, granular, ridged. Costæ well developed, and do not unite with those of other calices. Endotheca abundant, closing the calicular fossa as if by tabulæ.

Distribution.—Fossil. Cretaceous: England.

Genus STYLOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 250, *amended.* (See Pal. Indica, ser. xiv. Corals of Sind, for illustrations.)

The colony is in the form of a thick lamina with the base covered with a well-developed epitheca. The corallites are united by their walls, which are thin and prismatic. The calices are polygonal, with simple margins. The columella is styliform and projecting. The septa are thin, not numerous. At some of the angles where calices join, there are erect columns, narrow-grooved and various in height according to the species. In perfect forms these columns are either pointed at the top, or bear an aborted calice, the groovings and intermediate ridges being the intercostal spaces and costæ. Gemmation marginal.

Distribution.—Fossil. Oolite: England. Eocene: England, Europe, Sind in Asia, West Indies. Miocene: Europe.

Mr. Tomes has described two species of a genus which he has diagnosed and named *Bathycœnia.* The habit of the forms is that of *Stylocœnia*; and the nodular elevations between the calices are clearly in relation to gemmation. The descriptions and figures of the Stylocœnians from Sind, Pal. Indica, ser. xiv. ('Fossil Corals and Alcyonaria from Sind,' 1882), were doubtless unknown to Mr. Tomes. The worn condition of the calices of the *Bathycœniæ*, which are very rare corals, is evident; but the columella, although ragged in transverse outline, may have been styliform.

I mention the genus, but do not place it definitely.

Genus BATHYCŒNIA, *Tomes, Quart. Journ. Geol. Soc.* 1883, p. 176.

Colony turbinate, attached. Corallites united intimately by their walls. Investing common wall costulated, and has epitheca. Calicular surface convex. Calices more or less pentagonal, or rounded and deep. Septa entire, thin, project but little into the calice, rise in obtuse points where they meet those of other calices on the wall. Primaries meet to form a ragged columella. Calicular angles with obtuse points. Gemmation at obtuse points.

Distribution.—Fossil. Oolite: England.

XI. Alliance ISASTRÆOIDA.

Agglomerate Astræidæ, increasing by gemmation within the calice Walls of corallites fused. Occasionally the fusion is deficient near the calice or low down. Septa denticulate or entire.

Tribe I. Septa denticulate.
Genus Isastræa, Ed. & H.
Genus Prionastræa, Ed. & H.
Genus Placastræa, Stol.
Genus Elysastræa, Laube.
Genus Lepidophyllia, Duncan.

Tribe II. With entire septa.
Genus Aplocœnia, Ed. & H.
Genus absorbed :—
Metastræa, Ed. & H.

Tribe I.

Genus Isastræa, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 526 (1857).

Colony massive, convex, gibbous, subdendroid or incrusting. Corallites prismatic, and intimately united by their walls, which are simple throughout. The calices have a polygonal outline, which is simple and ridge-like. The columella is rudimentary or absent. The septa are thin, close, granular, denticulate. Endotheca fairly well developed. The common base is marked with fascicles of costæ, and has a thin epitheca. Gemmation calicinal and submarginal. Occasionally the calicular walls are slightly apart near the calice.

Distribution.—Fossil. Trias: Europe. Infra-Lias, Lias, Oolites: England and Europe. Cretaceous: England, Europe, India. Eocene: Europe, India (Sind). Miocene: West-India Islands.

Genus Prionastræa, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 513, pl. D 8. fig 1 (1857).

Syn. *Metastræa*, Ed. & H.

Colony large, massive, convex, with or without ascending lobes, subplane, hemispherical, gibbous. Corallites close, prismatic; their walls are united above but usually not below. Calices polygonal and deep, or not large; margins simple or in crests. Columella spongy, variable in development. Septa thin, narrow above, close, granular, and very finely serrate, the longest teeth

being near the columella. Endotheca well developed. Epitheca thin and complete.

Distribution.—Fossil. Oligocene: India (Sind). Miocene: Europe.—*Recent.* Indian Ocean, Red Sea, Pacific, Australian seas, West Indies.

The genus *Metastræa*, Milne-Edwards and Jules Haime, Hist. Nat. des Corall. vol. ii. p. 525, cannot be considered in the light of a genus when contrasted with *Prionastræa*. The only distinction is one of growth, and in *Metastræa* the walls are compact in their whole height. This compactness is seen in portions of species of *Prionastræa*.

Metastræa is absorbed in *Prionastræa*.

Genus PLACASTRÆA, *Stoliczka, Cretaceous Corals of Southern India, Palæontographica Indica*, vol. iv. (4) 1873, p. 33, pl. vii. fig. 1.

Colony massive, convex. Corallites united by their walls, which are fused. Calices irregularly disposed, close, polygonal, separated by ridges. Columella lamellar, solid, with a finely granulated upper edge. Septa numerous, close, finely denticulate and granular, confluent over the narrow calicular wall.

Distribution.—Fossil. Cretaceous of Southern India.

This genus resembles *Isastræa*, but there is the addition of a lamellar columella. The method of increase is not given by Stoliczka; but it certainly was not fissiparous, as in *Lamellastræa*, Duncan.

Genus ELYSASTRÆA, *Laube, "Faune der Schicht. von St. Cassian," Denks. der Kais. Akad. der Wiss. Wien*, 1864, Bd. xxiv. p. 261.

Colony cæspitose, subplane above, composed of corallites springing from a base of greater or less width, united by their walls or by costæ to a certain extent high up. Calices irregular in shape, usually united to their neighbours by a broad surface. Columella rudimentary or spongy. Septa unequal, flexuous, serrate. Endotheca abundant. Gemmation within the calices. Epitheca exists.

Distribution.—Fossil. St. Cassian deposits: Europe. Infra-Lias: England.

Genus LEPIDOPHYLLIA, *Duncan, Brit. Foss. Corals, Pal. Soc.* pt. iv. no. 2, p. 53 (1868).

Colony flat or tall, with corallites overlapping but joined by their walls. Calices more or less circular and deformed, widely open. Columella absent. Septa dentate. Gemmation in the centre of the calices. Epitheca distinct. Endotheca present.

Distribution.—Fossil. Jurassic: England.

Tribe II.

Genus APLOCŒNIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 281, pl. D 3. fig. 1 (1857), *more defined.*

Colony thin, with a convex surface. Corallites united by their walls, and prismatic. Calicinal walls very thin, and in zigzags. Calices superficial, unequal, large. Axial space empty and small. Septa thick, unequal, straight, smaller internally, entire; systems irregular.

Distribution.—Fossil. Eocene: Europe.

XII. Alliance LATIMÆANDROIDA.

Agglomerate Astræidæ, increasing by calicular gemmation. Calices single or multiple, in valleys. Corallites united by their walls completely or incompletely at the surface. Septa denticulate. Endotheca present.

Genus LATIMÆANDRA, Ed. & H.

Genus HETEROGYRA, Reuss.

Genera absorbed:—CHORISASTRÆA, E. de From.; MICROPHYLLIA, d'Orb.; CORMOPHYLLIA, d'Orb.

Genus LATIMÆANDRA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 543 (1857).

Syn. *Microphyllia*, d'Orb.; *Cormophyllia*, d'Orb.; *Chorisastræa*, E. de From.

Colony massive, variable, convex, with a broad or narrow base, or pedunculate or subturbinate, subplane, or subdendroid. Corallites united by their walls, fusion not always perfect. Calices some circumscribed, others in short series with their centres distinct. Columella rudimentary. Septa numerous, thin, close, laterally granulate; dentations fine and subequal. Common wall costulate, without epitheca. Endotheca scanty. Gemmation calicinal and submarginal.

Distribution.—Fossil. Trias, Jurassic: Europe and England. Cretaceous, Eocene: Europe. Eocene: Sind, Asia, and Borneo. Miocene: Sind.

The genus *Latimæandra* is a very large one, and follows the rule which is noticed under such circumstances; it is ill defined from some others. During the growth of vigorous individuals remarkable changes occur in the arrangement and relation of the calices. The union of the elongate calices by their walls with their neighbours is the completion of the generic definition; but it sometimes does not occur everywhere in the same large corallum or colony, and here and there the walls are not united, there being a distinct crevice between them. Were a fossil specimen to be broken and part of it to retain the true Latimæandroid structure and the rest to show the incomplete union, the latter would be considered generically distinct from the former by M. de Fromentel, and would be called *Chorisastræa*.

Now A. E. von Reuss described and figured, in his description of the Fossil Anthozoa of the strata of Castelgomberto*, beautiful specimens of *Latimæandra circumscripta*, *L. marchelloides*, and *L. dædalæa*, in which the true character is present; and also equally well-preserved types of *L. discrepans* and *L. dimorpha*, in which the walls are separate (plates 5–8). No one can doubt that all these forms belong to one genus, and that there is no necessity for the experiment of introducing *Chorisastræa* to separate the last from the first.

The same author carried the matter further, for he describes (*op. cit.* p. 20, pl. v. figs. 2–3) a type in which there are calices of the true Latimæandroid type, others separate and Chorisastræan, and many others which are circular in outline and free all round to a considerable depth, looking like a combination of *Thecosmilia*, *Latimæandra*, and *Chorisastræa*. The specimens are large, and their habit of irregular growth and irrregular calicular junction is most suggestive in a classificatory sense, because there is a constant springing up of independent buds which sooner or later become serial in their calices, and at last unite by their walls. The colony is never entirely Latimæandran, Chorisastræan, or Thecosmilian.

It is the independence of the circular calices, which is so unlike anything Latimæandran, that characterizes amongst other things *Heterogyra*, Reuss. The type *H. lobata*, Reuss, cannot possibly come within the genera already mentioned.

* "Pal. Stud. über die ält. tertiärsch. der Alpen," Denkschr. d. Kais. Akad. Wiss. Wien, 1867–68, p. 21 *et seq.*

M. de Fromentel writes ('Introd. à l'étude des Polyp. foss.' p. 163), "Nous avons séparé des Latiméandras des fossiles qui présentent bien comme celles-ci *des calices réunis en séries*, mais dont les séries restent libres par leur côté et ne sont même pas unies des côtés. Nous avons réuni les quelques espèces qui présentent ce caractère sous le nom générique de *Chorisastræa*."

Hence it is only to corals with serial calices that *Chorisastræa* can apply.

In the Pal. Franç., Zooph. Terr. crét. p. 445, M. de Fromentel states that the genus *Chorisastræa*, E. de F., 1858, includes the Syrrastræans which increase by budding, but whose series rest free at the summit, and are not united dorsally or by their costæ.

It is remarkable that M. de Fromentel should classify *Latimæandra* with corals having serial calices. E. Pratz has pointed out that this is an error. *Latimæandra* has not what M. de Fromentel calls a Syrrastræan type of growth, but a Disastræan or Polyastræan (see *Latimæandra Flemingi*, Ed. & H.). *Latimæandræ* are modified Isastræans; and these last, like *Latimæandra*, often have their calicular walls separated for a short distance downwards.

Many genera have the walls united, except close to the calices, and during growth union takes place there.

Heterogyra, Reuss, cannot be included in the so-called genus *Chorisastræa*. I do not think it advisable to retain this last genus.

Genus Heterogyra, *Reuss, Pal. Stud. ü. die ält. tertiärsch. der Alpen*, Abth. i., *Anthoz. v. Castelgomberto*, Wien, 1868, p. 20.

Colony massive. Corallites increasing by gemmation and irregular serial calicinal growth, united inferiorly, free superiorly. Calicular surface irregular, showing nearly circular and very deformed calices, free from the calicinal margin down to a certain depth. Septa numerous, denticulate. Columella absent. Endotheca exists, but an epitheca does not cover the costæ.

Distribution.—Fossil. Eocene: Europe.

The alliance of this form is with the Latimæandroids and not with the Symphyllioida. Its importance is considerable in relation to the so-called genus *Chorisastræa*, E. de From., and the morphology of *Latimæandra* also.

The genus *Merulina* was placed by Milne-Edwards and Jules

Haime as a unique genus or a group of Pseudo-Fungidæ, because of the *Agaricia*-like appearance and perforated wall. Dana placed the genus in the Astræidæ, and I think that is its proper position; for the perforations are not more than growth-apertures and do not always exist; and in forms where there are calices on both sides of the common wall there are no perforations. I do not retain the group Pseudo-Fungidæ in the sense of M.-Edwards and Haime.

Group-Genus Merulina.

Genus Merulina, *Ehrenberg*, *Corall. des Roth. Meer.* p. 104 (1834), *amended.*

Colony fixed, foliaceous, frondiform, folded, or subdendroid. Corallites in linear series with fused walls, having simple ridges crossed by septo-costæ. Calices with centres distinct, in small series, confluent by their septo-costæ. Columella slightly developed, spongy or tubercular. Septa stout, sharply denticulate, trabeculate, here and there few, granular at the sides. Common plateau, when it exists, is striate and echinulate along long and somewhat diverging lines, bound as it were in long groups, between which are perfect foramina near the edge of the colony, and deep depressions like slits elsewhere. Where the colony is not foliaceous and is solid, there is no common plateau, and there are no perforations, the calices being on all sides. Endotheca scanty, often only seen at the columella. Gemmation submarginal and calicinal.

Distribution.—Recent. Indo-Pacific, Pacific Ocean.

XIII. Alliance PLERASTRÆOIDA.

Agglomerate Astræidæ increasing by calicular or extra-calicular gemmation. Septo-costæ confluent. Dissepiments present. No synapticula. Septa denticulate and entire.

Genus Plerastræa, Ed. & H.
Genus Holocœnia, Ed. & H.

There is some difficulty in placing the next genus, *Plerastræa*, in its proper classificatory position. According to Milne-Edwards and Jules Haime its position is next to the genus *Clausastræa*, d'Orb., in the Astræidæ. But in a species I described from the Eocene of Sind I found synapticula. By a printer's error this form has been termed *Pterastræa.*) The figure given by Milne-Edwards and Jules Haime in the Ann. des Sci. Nat. 3e sér. t. x. pl. 9. fig. 12, leaves no doubt about the

Astræid nature of their type species, *Plerastræa Savignyi*. *Clausastræa* has now to be removed from the true Astræidæ, for it has synapticula. *Plerastræa mirabilis*, nobis, Foss. Corals &c. of Sind, Pal. Indica, p. 65 (1880), cannot remain in its genus as determined by Milne-Edwards and Jules Haime. It is now *Pratzia mirabilis*, and a Lophoserine.

Genus PLERASTRÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 553 (1857).

Colony massive, turbinate, or flat, with a convex or subplane upper surface. Corallites limited by walls which are simple, united, and well developed. Calices superficial. Columella papillary. The septa few and subconfluent with those of the neighbouring calices, dentated, uniting more or less. Dissepiments well developed and abundant. An epitheca may exist and be strong and folded.

Distribution. — *Fossil.* Trias: Europe. Jurassic: England. Eocene: France.—*Subfossil.* Red Sea.—*Recent.* Red Sea?

The next genus is a doubtful one. If it has no synapticula it must remain; but if it has, it is synonymous with *Centrastræa*, a subgenus of *Thamnastræa*, Lesauvage.

Genus HOLOCŒNIA, *Milne-Edwards & Jules Haime, Brit. Foss. Corals, Pal. Soc.* p. 99 (1851).

Colony massive, gibbous. Corallites united by their costæ, which are slightly developed, or by their walls. The septa are entire, have their upper edge nearly horizontal, and merge into those of the neighbouring calices by means of the costæ, with which they are continuous. These septo-costæ hide the summit of the walls of the calices. The columella is styliform.

Distribution.—*Fossil.* Cretaceous: Europe, S. India. Eocene: Borneo.

This is not a satisfactory genus; see the admirable remarks of its founders (*op. cit.* p. 99, 1851). The South-Indian Cretaceous species has ragged septa and no synapticula.

XIV. Alliance TABULOIDA.

Agglomerate Astræidæ increasing by gemmation. Corallites united by their walls. Dissepiments in the form of tabulæ. Septa variable, in cyclical arrangement.

Genus HOLOCYSTIS, Lonsdale.

Genus COCCOPHYLLUM, Reuss.

Genus absorbed:—TETRACŒNIA, d'Orb.

Genus Holocystis, *Lonsdale, Quart. Journ. Geol. Soc.* t. v. p. 83 (1849); *Milne-Edwards & Jules Haime, Brit. Foss. Corals*, p. 70, pl. x. fig. 5 (1850).

Syn. *Tetracœnia*, d'Orb.

Colony in a convex mass, increasing by extra-calicular gemmation. Corallites united directly by their walls or by costæ, which are thick and usually well developed. Calices subpolygonal, either united by their margins or separated by a broad groove; fossula deep. Columella very small, styliform. Septa entire, in three complete cycles; four primaries much more developed than any other septa, exsert, close, thick at the margin and beyond, feebly granular, and very unequal according to their orders. Dissepiments of one kind, simple, horizontal, equidistant, and corresponding in height in the different interseptal loculi, forming tabulæ, which are traversed by the primaries.

Distribution.—Fossil. Lower Cretaceous: England. Aptien: Europe.

Genus Coccophyllum, *Reuss*, "*Anthozoen der Kössenerschichten und der alpinen Trias*," *Sitzungsb. der Kais. Akad. der Wiss. Wien*, 1865, p. 167.

Colony broad, convex. Corallites united by their irregular-shaped walls. Calices of various sizes, polygonal. Columella absent. Septa projecting but little into the calice, distinctly granular at their free edge. Tabulæ abundant, stretching across the interior of the cylindrical corallite, and often with a concave upper surface. Gemmation from the calicular wall.

Distribution.—Fossil. Trias: Europe.

The next genus stands much alone. The young calices surround the larger parent, and arise by marginal budding. The walls are thin, and almost rudimentary where the buds join. The endotheca is very abundant, coming high up, and centrally there are tabulæ. A rudimentary columella exists.

It must form a group with affinities with the Rugosa, like the Alliance just noticed.

Group-genus Moseleya, *Quelch.*

Genus Moseleya, *Quelch, Ann. & Mag. Nat. Hist.* 1884, vol. xiii. p. 292.

Corallum compound (colony), flattened, or slightly and broadly convex. Young calicles developing by calicinal marginal budding

around a very large median calicle, which has very numerous septal orders, the calicles becoming polygonal and deep at the centre. Epitheca very slight; wall very thin and almost rudimentary, but developed so as to give a distinct simple line of separation to the calicles on the surface, often interrupted; seen in section in a very rudimentary state separating the calicinal centres. Costæ very distinct, thin, and finely denticulate. Septa often confluent and continuous, from centre to centre, in the line of union between adjoining calicles, very thin and close, finely toothed above, and having the teeth subequal or slightly larger near the centre. Endothecal dissepiments vesicular, very abundantly developed, leaving but a very small portion of the septa free exteriorly; seen in transverse section forming nearly concentric lines, and more or less complete tabulæ at the centre. A false columella present, seen exteriorly to be formed by the trabeculate and vermiform nature of the innermost upper part of the septa, entirely or almost absent in transverse section, where the septa are seen to meet almost at a point.

Distribution.—*Recent.* Torres Straits.

The next and last genus of this family is placed at the close of it provisionally. It will not conform to any Alliance, although it has some Latimæandroid characters of growth.

Group-genus DICTYOPHYLLIA, *Blainville.*

Genus DICTYOPHYLLIA, *Blainville, Man. d'Actin.* p. 360, pl. 53. fig. 4; *Dict. des Sci. Nat.* t. lx. p. 523 (1830), *amended.*

Colony incrusting, covering considerable space. Surface subplane. Corallites low, separated by very narrow grooves at the calicular surface, variable in size. Calices more or less polygonal or circular, or long, nearly or quite straight, narrow, looking like a series with perfectly indistinct centres. In a polygonal calice (one of a bud) are numerous subequal, close, short septa projecting from the wall a little way inwards, and within these, towards the calicular centre and occupying a large space, is a columella—a mass of trabeculæ, reticulate and slightly convex; trabeculæ connected, here and there, by cross bars. The long calices show the same structures as the others—a wall with short subapical septa projecting a little, and a large long axial mass of trabeculæ—the columella. The columella appears to rise from a flat floor, which is presumably the base of the colony. Costæ absent. Calicular walls separated.

Distribution.—Fossil. Upper Cretaceous: Maestricht, Europe. There are several very perfect specimens of the only species of this remarkable genus in the British Museum. Their appearance and structural characters are, to a certain extent, those of the serial Astræidæ.

CHAPTER V.

The Section Fungida of the Madreporaria, definition, families. The family Plesiofungidæ, its groups and alliances and genera. The family Fungidæ, alliances and genera. The family Lophoseridæ, alliances and genera. The family Anabaciadæ, and genera. The family Plesioporitidæ, alliances and genera.

II. Section MADREPORARIA FUNGIDA *.

Madreporaria solitary or in colonies. Septa and septo-costæ with synapticula which cross the interseptal and intercostal loculi. An endotheca may or may not exist. Septal laminæ solid or presenting degrees of fenestration. Basal structures perforate or imperforate. Soft structures with short, lobe-like, scattered, sometimes obsolete, tentacles, not covered when contracted; disks not circumscribed, and in colonial forms confluent.

The reasons for adding two families to this section have been given in a former page (4).

Families.

(Transition-group.) I. PLESIOFUNGIDÆ.
II. FUNGIDÆ.
III. LOPHOSERIDÆ.
IV. ANABACIADÆ.
(Transition-group.) V. PLESIOPORITIDÆ.

The family Plesiofungidæ contains 13 genera, of which 10 are taken from the family Astræidæ of Edwards and Haime. The Fungidæ contain 10 genera. Two new genera enter, and the old form, *Zoopilus*, finds a place. *Haliglossa* becomes a subgenus; and *Podabacia* is synonymous with *Halomitra*.

* Verrill makes a suborder Fungacea, and foreshadowed the present amplification of the Fungida in 1865 (see Verrill, 'Notes on Radiata,' a work full of valuable information)

The Lophoseridæ become a very important family, and there are 35 genera and 2 subgenera. Out of the 19 genera of Milne-Edwards and Haime, 3 are passed on to the Plesioporitidæ, so that there are 19 new genera added.

The Anabaciadæ remain as they were, 2 genera.

The Plesioporitidæ have 13 genera; 1 was formerly an Astræid, 3 were Lophoseridæ of Ed. & H.; 9 genera are thus added.

The section Fungida contains therefore 73 genera and several subgenera.

Besides these 73 genera, 23 have been recorded, and either abolished in revision, or in some instances made subgenera.

Transitional Family.

I. Family PLESIOFUNGIDÆ *.

This family unites more or less the Aporosa and Fungida.

Fungida simple or colonial, with synapticula in the interseptal loculi, besides endothecal dissepiments. Septa solid and imperforate, occasionally irregularly perforate and trabeculate.

This Family contains five groups. One genus can hardly be satisfactorily placed, because nothing is known regarding the nature of the septa; but, provisionally, I place it in a group by itself. This is *Epistreptophyllum*, Milaschewitsch.

E. Pratz unites *Siderastræa*, *Astræomorpha*, and *Mesomorpha* in a group; but I cannot agree to the union of the last two with the first-named. Hence *Siderastræa* stands as a genus alone. The Thamnastroid group is fairly well defined.

Group-Genus EPISTREPTOPHYLLUM.

A simple Plesiofungid.

Genus EPISTREPTOPHYLLUM, *Milaschewitsch*, "*Korallen der Nattheimerschichten*," ii. Abtheil., *Palæontographica*, xxi. p. 210 (1875).

Corallum simple, adherent, conical or cylindrical. Calice sunken. Columella well developed and spongy. Septa numerous, not exsert. Wall ornamented with subequal costæ. Deeply in the interseptal loculi are endothecal dissepiments, and, besides,

* See Verrill, 'Notes on Radiata,' p. 540, E. Pratz, 'Palæontographica,' 1882, and Zittel, Palæontology, foreshadowing this group.

numerous synapticula; but in the upper parts there are only numerous sharp-pointed wart-shaped granules on the sides of the lamellæ.

Distribution.—Fossil. Jurassic: Europe.

Group-Genus SIDERASTRÆA, Blainv.

Genus SIDERASTRÆA (pars), *Blainville, Dict. des Sci. Nat.* t. lx. (1830); *Milne-Edwards & Jules Haime, Compt. Rend. de l'Acad. des Sci.* t. xxvii. p. 445 (1848); *amended after Pourtalès.*

Syn. *Astræa*, Ed. & H. (1857).

Colony massive, convex or plane, dense, incrusting. Corallites united by thin and often indistinct walls. Calices subpolygonal, deep, margins rounded. Columella small, papillary, made up of ascending trabeculæ, which often fuse, here and there, into a mass. Septa solid, rather close, thin, denticulate where free, often uniting. Two rows of synapticula close to the wall unite the opposed septal lamellæ, and tend to fill up the interseptal loculi near the wall. Septa imperforate. Endothecal dissepiments few. Gemmation submarginal.

Distribution.—Fossil. Eocene: Europe, Asia. Miocene: Europe, West Indies.—*Subfossil.* Red Sea.—*Recent.* Red Sea, Indian Ocean, islands off West coast of Africa, Caribbean Sea.

L. Agassiz states that the soft parts of *Siderastræa* are those of the Fungida and not those of the Astræidæ, and the tentacles drawn by Pourtalès prove this.

Group-Genus POLYARÆA.

Genus POLYARÆA, *K. v. Fritsch,* "*Foss. Korall. der Nummulit. v. Borneo,*" *Palæontographica,* Supp. Band iii. (1878).

Colony massive, with projecting calices. Corallites free above, united by wall and costæ below. Septa numerous, arched, uniting, perforate. Columella spongy and well developed. Dissepiments vesicular. Synapticula present. Epitheca well developed, uniting approximated corallites, wrinkled and striated. Gemmation lateral and basilar. Colony increases circumferentially.

Distribution.—Fossil. Eocene: Borneo.

K. v. Fritsch states that the colony has the habit of *Brachyphyllia*, Reuss.

I. Alliance ASTRÆOMORPHOIDA.

Colonial Plesiofungidæ. Calices small, more or less confluent by costæ. Walls absent. Septa trabeculate, but solid. Columella styliform.

Genus ASTRÆOMORPHA, Reuss.
Genus MESOMORPHA, Pratz.

Genus ASTRÆOMORPHA, *Reuss*, "*Beiträge zur Charak. d. Kreid. in den Ostalpen*," *Denks. d. Kais. Akad. Wiss. Wien*, 1854, Band vii. p. 127.

The colony is flat, with small irregular calices, having only from 6 to 16 thick dissimilar irregular septo-costæ only slightly geniculate. The central septa unite with a compact styliform, but sometimes rudimentary, columella. Septa not united directly with the columella along their entire height, but by trabeculæ occurring at regular intervals from ·5 to ·75 millim. apart, so that a series of openings exists on the boundary between septum and axis. Tolerably stout, transverse or slightly oblique dissepiments stretch across the interseptal loculi, agreeing with the axial trabeculæ in number, but alternating with them. Hence a number of superimposed cavities occur in the interseptal loculi.

Reuss notices the affinity of the genus to *Clausastræa*, and how it is distinguished from that genus and *Thamnastræa*.

E. Pratz (Palæontographica, 1882, p. 103 *et seq.*) analyses the species of this genus, and states that the genus is essentially Triassic, the specimens studied by Reuss from supposed Cretaceous rocks being derived fossils. The species described by Milaschewitsch from Nattheim are Thamnastræans, and differ in their morphology from *Astræomorpha*. The Eocene species is a *Thamnastræa*.

E. Pratz remarks on the morphology. The septa, instead of being formed of many trabeculæ passing from the internal base of the corallite upwards and inwards, give the impression of being formed by an independent irregularly-formed trabecule composed of many nodules running upwards and outwards. The granulations group themselves at tolerably regular intervals, and form more or less horizontally placed enlargements, which run in the same plane around each septum. In transverse sections, calcareous threads are seen to radiate from the middle of a septum to the periphery. A vertical section shows that they are directed upwards and outwards. The dissepiments resemble tabulæ. The

septa are compact, and are united by tabulæ and synapticula. There is no intercalicular wall.

Distribution.—Fossil. Trias: Europe.

Genus MESOMORPHA, *Pratz, Palæontogr.* xxix. (1882), p. 118.

Syn. *Porites* (pars).

Colony massive, branching, gibbous, sometimes incrusting. Calices small, shallow, not defined by ridges, but confluent with septo-costæ running in low curves over a flat surface. Septa compact, with spinules on the sides and edge, indicating a trabeculate construction. Columella styliform. No true wall. Synapticula stout, and when in the sclerenchyma between the corallites giving a cœnenchymatous appearance. Dissepiments exist.

Distribution.—Fossil. Cretaceous: Europe.

II. Alliance THAMNASTROIDA.

Colonial Plesiofungidæ, varying in shape, massive, foliaceous, dendroid, incrusting or not. Confluent septo-costæ well developed, usually solid, trabeculate. Calices superficial, widely open, large.

Genus THAMNASTRÆA, Lesauvage.
Subgenus CENTRASTRÆA, d'Orb.
Genus CLAUSASTRÆA, d'Orb.
Genus PSEUDASTRÆA, Reuss.
Genus PIRONASTRÆA, d'Achiardi.
Genus REUSSASTRÆA, d'Achiardi.
Genus DIMORPHASTRÆA, d'Orb.
Genus DIMORPHOCŒNIA, E. de From.
Genus STYLOMÆANDRA, E. de From.?

Genus THAMNASTRÆA, *Lesauvage, Ann. des Sci. Nat.* 1e sér. t. xxvi. p. 328 (1832).

The synonymy of this great genus has been correctly given by Milne-Edwards and Jules Haime, 'Hist. Nat. des Corall.' vol. ii. p. 555 (1857), and carried down by them to 1851. M. de Fromentel's 'Introd. à l'étude des Polyp. foss.' (p. 211), published 1858–1860, is unfortunate in not bringing in the synonymy published by Milne-Edwards and Jules Haime, and in not noticing their able work.

Lesauvage, Goldfuss, Blainville, d'Orbigny, Lamouroux, and Defrance differed in their views regarding the genus; and Milne-Edwards and Jules Haime, criticizing the results of these naturalists, and having an immense amount of original matter at hand,

established a new generic diagnosis. Later on Etallon, Reuss, nd myself decided that the genus must enter the Fungida; and since that time it has been placed in the Poritidæ by Milaschewitsch and R. Tomes, and replaced by the latter in the Fungida. The careful researches of E. Pratz enable me to place the genus in the transitional group between the Astræidæ and Fungida—in the family Plesiofungidæ.

Milaschewitsch, noticing the perforate condition of the septa of Thamnastræans from Nattheim, was led away to believe that this condition was invariable in the genus. Moreover, he thought that a perforate septum necessitated a Porosa alliance. There are perforate septa in *Cyphastræa*, an aporose form, and solid septa in most species of *Madrepora*, a perforate genus. Perforation may be noticed in some English Thamnastræans that have been much weathered, but in parts of the colony only. The condition is not universal in specimens from Nattheim, and is the result of destructive siliceous fossilization and weathering.

The trabeculæ of the septa do not always leave spaces between them like lattice-work; such a condition is local and exceptional. At the same time the thinnest part of the septum is between the nodular masses of the trabecules. There is no doubt that the septa are united by growths which are not exaggerated granules, and which are synapticula. These not only interfere with the open condition of the interseptal loculi, but make the position occupied by any thing like a mesenteric fold very shallow. The existence of endotheca is decided, and especially in some Oolitic species. It was noticed by Milne-Edwards and Jules Haime, and figured in my Monog. Brit. Foss. Corals, Pal. Soc. 1872, Pt. iii. pl. 4. fig. 9, and has been recognized in continental forms.

The presence of a wall bounding the corallites has been debated. I do not find a true wall, but that synapticula are often placed in vertical series and act as a wall, which, however, is not complete. Often no trace of such a limiting series can be found. On the other hand, the existence of a wall has been stated by De Fromentel. The columella is variable in the genus, and has been used to establish subgenera. Finally, the colony is sometimes convex, plane, and nodulose, or decidedly branched. The structures in these forms are identical, and therefore the old plan of making the branched forms into a new genus or subgenus has been abolished.

The subgenera are not very satisfactory, on account of the influence of fossilization and wear and tear in destroying the columella or in modifying it. But if it can be established that a species has had no columella, or has a papillary one, or one which is essential and styliform or knobbed, it is right to put it in the characteristic subgenus. Thus the true Thamnastræans, according to Milne-Edwards and Jules Haime, have a papillary columella (Hist. Nat. des Corall. vol. ii. p. 555). The Thamnastrææ with a knob or styliform process for columellæ belong to the subgenus *Centrastræa*, d'Orbigny. In most cases sections show the relics of the columella.

Mr. R. Tomes, F.G.S., follows M. de Fromentel in his classification (Quart. Journ. Geol. Soc. 1882, p. 434), and gives him the authorship of *Synastræa* as well as *Centrastræa*, the first being a creation of Milne-Edwards and Jules Haime, and the last of d'Orbigny! As the subject has been now thoroughly discussed, it is only necessary to revise the genus *Thamnastræa* after Milne-Edwards and J. Haime, and to admit, for the sake of convenience, *Centrastræa* as a subgenus. Mr. R. Tomes suggests the term *septal-costæ* for the costæ which join the septa of different calices in *Thamnastræa*. The term *septo-costæ* was used half a century ago, and has been employed ever since, and is the better term of the two.

Genus THAMNASTRÆA, *Lesauvage, amended*; *post. Ed. & H.* (1857), *Hist. Nat. des Corall.* vol. ii. p. 555.

Syn. *Synastræa*.

Colony massive, convex, subplane, or gibbous, or thin and expanding, or in layers, pedunculate or with a broad base, or incrusting, or more or less dendroid in shape. Corallites indistinctly defined. They are united by costæ or by an ill-developed wall. Calices superficial, centres distinct, and the intercalicular space variable in extent. Columella variable, papillary, nodular, small, styloid. Septa merging into septo-costæ which are confluent with those of neighbouring calices, usually flat on the free border, dentate, the minute projections being the tops of lines of trabeculæ, stout or thin, solid or perforate here and there; straight, wavy, curved, or geniculate, long or short, often uniting or not. Dissepiments rudimentary or decidedly developed. Synapticula numerous, small. Gemmation submarginal. Common colonial wall, when it exists, costulate, epithecate, and with synapticula.

Distribution.—Fossil. Trias: Europe. Lias: England and Europe. Oolitic: England and Europe. Cretaceous: England, Europe, Asia. Eocene: Europe, Asia. Miocene: Tasmania.

Subgenus CENTRASTRÆA, (genus) *d'Orb.* (1847).

Thamnastræa with an almost styliform columella.

In recognizing this group care must be taken not to be deceived by the results of fossilization.

Genus CLAUSASTRÆA, *d'Orbigny, Note sur les Polyp. foss.* p. 9 (1849), *amended.*

Colony massive, with a plane or convex upper surface and broad base. Corallites large, without definite walls, which are replaced by a cellular endotheca. Calices superficial, shallow, widely open. Columella absent. Septa large, dentate, few, some confluent with the septo-costæ of the calices close by and others traversing the intercorallite space to reach somewhat distant calices, straight, or geniculate, or curved here and there. Laminæ short, solid. Endotheca replacing walls here and there, and stretching across the interseptal loculi high up like tabulæ, but not passing over the axial space. Synapticula small, short, stout, numerous. Gemmation submarginal.

Distribution.—Fossil. Jurassic: Europe, England.

Genus PSEUDASTRÆA, *Reuss, "Foss. Foram. Anthoz. von Oberburg," Denks. d. Kais. Akad. der Wiss. Wien,* Bd. xxiii. p. 24 (1864).

Colony massive. Calices crowded, irregular, rather deep in the centre, environed by a shallow groove, so that only occasional septa become continuous with those of other calices. Septa dentate and numerous. Columella ends in a small irregular pimple (*Höcker*). Pali in one crown. Synapticula exist, being placed very regularly. (Endotheca does not exist, according to Reuss.)

Distribution.—Fossil. Eocene: Europe.

Genus PIRONASTRÆA, *d'Achiardi, Corall. Eocen. del Friuli* (Pisa, 1875), p. 76.

Colony lamello-discoid. Calices in concentric circles, confluent, centres distinct and small. Columella absent, or as one papilla. Septo-costæ very large. Synapticula numerous. Endotheca scarce. Epitheca well developed.

Distribution.—Fossil. Eocene: Europe, Sind, Asia.

Genus REUSSASTRÆA, *d'Achiardi, Coralli Eocen. del Friuli* (Pisa, 1875), p. 67, tav. 13. fig. 2; *amended.*

Colony in the shape of a lamina more or less thick. Calices distinct, numerous, varying in their distances, shallow. Septa confluent with those of neighbouring calices. Columella lamellar and essential. Calicular wall ill defined. Dissepiments well developed, arched. Synapticula exist; and the solid septal laminæ are very granular.

Distribution.—Fossil. Eocene: Europe, Sind, Asia.

Genus DIMORPHASTRÆA, *d'Orbigny, Rev. et Mag. de Zool.* p. 177 (1850), *amended*; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 585 (1857).

The colony is pedunculate or not, flat on the upper surface, rarely convex, more or less circular in outline. Corallites arranged around a large central parent in distant concentric circles. Columella papillary and small. Septo-costæ confluent. Synapticula exist. Common wall striated or not, naked.

Distribution.—Fossil. Cretaceous: Europe, Hindostan, Asia.

Genus DIMORPHOCŒNIA, *de Fromentel, Polyp. foss. de l'étage Néocomien*, p. 55 (1857).

Colony in a tolerably thin lamina. Corallites disposed in concentric rows around a central parent. Plateau naked and costulated. The septa are entire, and almost all radiating from the centre to the circumference. There is no columella.

M. de Fromentel states that this genus corresponds in the Eusmilian family with the genus *Dimorphastræa*, the distinction being the entire nature of the septa in the first-named genus and the absence of a columella. There are synapticula.

Genus STYLOMÆANDRA, *E. de Fromentel, Pal. Franç., Terr. crét.* p. 457 (1877).

The genus *Stylomæandra*, according to M. de Fromentel, is clearly allied to the genus *Latimæandra*, and is only really distinguished by having a styliform columella in the centre of the calices.

The figure shows (pl. 113. fig. 3) a broad colline covered by confluent costæ. It appears that this genus is hardly near *Latimæandra*, and that it is possibly one of the Thamnastræan alliance, where it is placed with doubt.

II. Family FUNGIDÆ.

(Subfamily *Funginæ* (pars), Ed. & H. Hist. Nat. des Corall. vol. iii. p. 4, 1860.)

Simple or colonial forms, usually depressed, with the septa solid or occasionally porous. Synapticula crossing the interseptal loculi and uniting the septa without the presence of dissepimental endotheca. Wall more or less synapticulate or special, perforated and echinulate. Calices with radiating septa in the simple forms; with or without radiating lamellæ, along a central axial line, or scattered in the colonial forms. Tentacles short, scattered, sometimes obsolete.

This family stands very much by itself, and its genera are remarkable for their calicular structures and developments.

The Alliances are fairly natural, and are the

I. FUNGIOIDA.
II. CRYPTABACIOIDA.
III. HERPOLITHOIDA.

I. Alliance FUNGIOIDA.

Simple Fungidæ, more or less discoid.

Genus FUNGIA, Dana.
Subgenus HALIGLOSSA, Ehr.
Genus DIAFUNGIA, Duncan.
Genus MICRABACIA, Ed. & H.

Genus FUNGIA, *Dana, Zooph.* p. 318 (1846), *altered by Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 5 (1860), *amended*; *Duncan, Proc. Linn. Soc., Zool.* vol. xvii. p. 137.

Syn. *Lobactis*, Agass.; *Pleuractis*, Agass.; *Ctenactis*, Agass.

The corallum is simple and free in adult age, circular, subcircular, elliptical, lobed, or angular in outline; depressed or hemispherical, with a horizontal or dome-shaped base, which is costulate and perforate more or less. The calice conforms to the shape of the superficies of the corallum. Septa numerous, plain, lobed, dentate or spinulose on their free edge, the smaller uniting with the larger, which reach from the axial space to the more or less turned-down calicular edge. Small septa trabecular, the large solid. The columella trabecular and rudimentary. Interseptal loculi deep, and occupied by vertical or slanting rows of stout

synapticula, which form, with the sides of the septa, canals leading to the base, and sometimes communicating with the outside through the basal openings. Costæ on the bases of the septa, and united by synapticula, which constitute a false basal wall. Young corals adherent, subturbinate and pedicellate.

Distribution.—Recent and *Sub-fossil.* Pacific, Red Sea, Indian seas, Pacific coast of America.

The genus is a large one, and may be rather artificially divided into groups of species as follows:—

Group 1. *Fungiæ lacerantes.* Fungiæ with spiniform septal teeth.
" 2. *Fungiæ subintegræ.* Fungiæ with very small dentations.
" 3. *Fungiæ lobiferæ.* Fungiæ with the septa terminating above in angular lobes.

The genus *Haliglossa*, Ehrenberg, may be considered a subgenus of *Fungia*, and it includes elongate forms with a discontinuous axial space, and links the *Fungiæ* on to the genus *Herpolitha*.

Genus DIAFUNGIA, *Duncan, Journ. Linn. Soc., Zool.* 1884, vol. xvii. p. 417.

Corallum discoid, free, without trace of adhesion, not quite circular in outline, much broader than high. Base with a primary triangular piece extending beyond the centre, slightly projecting downwards, the rest of the coral grouping from its nodes and apex, so that there is an appearance of former fracture and subsequent growth. Calice unsymmetrical from the prolongation of the larger septa of the primary piece beyond the centre, and from the radiation of septa from the sides and apex of the primary piece to the edge of the disk or the margin.

Columella absent. Septa numerous, order confused, many join others near and remote from the margin. Larger septa exsert, arched near the margin, from which they rise perpendicularly, and low near the septa of the primary piece. Septa dentate and strongly granular near their free edge, solid and stout.

Costæ broad, unequal, often bifurcating, variously directed. At the margin each costa gives off a branch on either side to form, with the corresponding offshoot of the next costa, a septum. Hence the septa correspond with the intercostal spaces. Inter-

costal spaces regularly furnished with equidistant synapticula, presenting a regularly perforated appearance. Synapticula strongly developed between the septa, some reaching high up in the interseptal loculi. There is no true wall, the septo-costal structure being united by synapticula alone.

Distribution.—Recent. Korean Sea.

Were there symmetrical growth, and did the costæ radiate from a common centre, the form would come within the genus *Micrabacia* (Edwards and Haime, Hist. Nat. des Corall. vol. iii. p. 30, 1860). The genus is therefore a very interesting addition to the family Fungidæ, and must be placed between the genera *Fungia* and *Micrabacia*.

It is mimetic of the genus *Diaseris* of the Lophoserinæ.

The genus *Micrabacia*, Milne-Edwards & Jules Haime, requires some amendment; and having had the opportunity of studying some good specimens, I give the following amended diagnosis:—

Genus Micrabacia, *Milne-Edwards & Jules Haime, Hist. Nat. Corall.* vol. iii. p. 29 (1860), *amended.*

Corallum simple, free, lenticular, broader than high, convex above, slightly concave at the base, which has a circular outline. Calice with a small shallow axial depression, filled by a false columella, from which the principal septa radiate, being joined with those of higher orders towards the circumference. Septa numerous, solid, imperforate, arched above, with a perpendicular outer edge. Costæ distinct on the base, bifurcating at the edge, a process from two costæ forming a septum. Intercostal spaces continuous with the line of direction of the septa, crossed by synapticula in concentric rows, and perforate between the synapticula. Interseptal loculi crossed by large and small synapticula, which radiate from the base in discontinuous lines, bounding canalicular spaces continuous below with the intercostal openings, and above with the interseptal loculi high up. Costæ granular. Septa crenulate or minutely denticulate.

Distribution.—Fossil. Cretaceous: England, Europe.

II. Alliance CRYPTABACIOIDA.

Colonial Fungidæ. Calices all distinctly radiating.

Genus Halomitra, Dana.
Genus Sandalolitha, Quelch.
Genus Cryptabacia, Ed. & H.

Genus HALOMITRA, *Dana, Expl. Exped.* 1846, *Zoophytes*, p. 311; *P. Martin Duncan, Journ. Linn. Soc., Zool.* vol. xiii. p. 155 (1883).

Syn. *Podabacia*, Ed. & H.

Corallum compound, free or attached, convex or folded. Upper surface with a circular, funnel-shaped, large calice, surrounded with a ring of smaller calices. Septo-costal rays continuous from central calice to others and to the thin margin. Septa numerous, unequal, denticulate, some trabeculate in parts, solid otherwise. Synapticula long or short, vertical. Costæ marked on the perforate and echinulate base.

Distribution.—Recent. Red Sea and Indian Ocean, Oceania.

This genus absorbs *Podabacia*, Milne-Edwards and J. Haime, and therefore has a wider distribution.

Genus SANDALOLITHA, *Quelch, Ann. & Mag. Nat. Hist.* 1884, xiii. p. 293.

Corallum compound, flattened, free, much elongated, and very thin. Wall sparsely porous, and extremely reduced. Distinct costæ, closely granulated or very finely and bluntly echinulate, curving towards the short axis. Calices few, in the long diameter of the corallum; parent calicle very large, occupying the centre, forming almost the entire corallum, with very numerous septa, there being about seven complete cycles, but a much larger number of cycles incompletely developed on the long axis; smaller calicles very few, distinctly radiate, developing on the course of and interrupting the larger septa in the long axis of the parent calicle. Septa very long, crowded, curving towards the short axis, and of more or less equal vertical extent, very low, giving an even laminate appearance to the corallum. Synapticula well developed, and forming strong connexions at the basal parts of the septa. Columella rudimentary and trabeculate.

Distribution.—Recent. Tahiti.

Genus CRYPTABACIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 22 (1860).

Corallum compound, free, oblong, convex above and concave beneath. Calices with radiating septo-costæ, some calices occupying the central axial line and there are others on either side. Septo-costæ short and not numerous. Inferior surface echinulate and perforate.

Distribution.—Recent. Indian Ocean, Manilla, Pacific.

III. Alliance HERPOLITHOIDA.

Colonial Fungidæ, with some or all the calices incomplete and not radiating.

Genus HERPOLITHA, Eschholtz.
Genus POLYPHYLLIA, Quoy.
Genus LITHACTINIA, Lesson.
Genus ZOOPILUS, Dana.

Genus HERPOLITHA, *Eschholtz, Isis,* p. 746 (1825), *amended; Duncan, Journ. Linn. Soc., Zool.* vol. xvii. p. 152 (1883).

The corallum is free, long, narrow, and compound. The upper surface has calices of two kinds—one set occupy a long central axial line and are multilamellar, and the other set are placed irregularly, have few lamellæ, and are small. The septo-costal rays are long and stout, and alternately thick and thin, and all are entire. No rays reach from the axial furrow to the circumference. The base is concave, perforated and echinulated. Synapticula regular, numerous, oblique, tall, and wanting here and there. Columella trabecular.

Distribution.—Recent. Red Sea, Indian Ocean to east.

This genus has been called *Herpolithus* by Leuckart subsequent to Eschholtz (see Hist. Nat. des Corall., Milne-Edwards & Jules Haime, vol. iii. p. 24); and Klunzinger has restored the proper name ('Korallenthiere des Rothen Meeres,' p. 68).

Genus POLYPHYLLIA, *Quoy et Gaimard, Voy. de l'Astrolabe (Zooph.),* p. 185, pl. 20 (1833); *Dana, Explor. Exped., Zooph.* p. 316 (1846).

Corallum compound, free, oblong, and convex above and concave below, or discoid. Calices incomplete; some, which are subradiant, occupy the central axis in the long coralla, and are associated with rudimentary calices placed on either side, with short septo-costal rays very unequal in size, separated by transverse laminæ, which are the prolongations of a lower set of septa. Or the surface is covered with undeveloped calices with non-radiant septo-costæ. The base is echinulate and perforate. Synapticula well developed. Principal septa very thick.

Distribution.—Recent. Pacific, Red Sea.

There are no perfectly radiating calices in the genus *Polyphyllia*—that is to say, the centre of a calice has not septa radiating from it, as in *Halomitra* for instance. The radiation is

interrupted. Besides, there are what may be called false calices, in which a large septum is covered over for a short distance by a kind of hood coming from some of the higher orders next to it. This structure appears to have one large fleshy tentacle upon it.

In the genus *Lithactinia* there are no subradiating calices in the median line, and all are of the false kind. This appears to be of generic importance, and I retain the genus. The genera *Herpolitha*, *Polyphyllia*, and *Lithactinia* form an Alliance on account of the presence of false calices in their compound coralla.

Genus LITHACTINIA, *Lesson*, *Illustr. Zool.* 1833; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 28 (1860).

Colony free and thin, hemispherical, cap-shaped, or almost plane above, and echinulate and perforated at the concave base. Costæ not distinct. Calices of one kind, nonradiate, and formed by short septo-costal laminæ, which are separated from those before and behind by thin transverse processes, which arch over them, and come from inferior septa. There are no true calices. Synapticula present.

Distribution.—*Recent.* Pacific islands, Oceania.

Genus ZOOPILUS, *Dana, Zoophytes, U. S. Exploring Exped.* 1846, p. 51.

Colony free, budding and explanate. Polyps everywhere scattered; mouths radiately seriate. Coralla with the larger lamellæ radially prolonged quite to the margin, the intermediate much smaller and short, and these alone interrupted by the oririmes (small depressions or centres of radiation = polyp-mouths). Polyp-mouths in the intervals between the large lamellæ.

Distribution.—*Recent.* Pacific.

III. Family LOPHOSERIDÆ.

(Subfamily *Lophoserinæ*, Ed. & H.)

Fungidæ in which the wall is neither perforated nor echinulate. Synapticula exist, but not endothecal dissepiments. Septal laminæ usually solid, but occasionally with ill-defined perforations, remote from the bottom of the septa.

Very considerable changes have taken place in the old subfamily of Milne-Edwards and Jules Haime, the *Lophoserinæ*, owing to the introduction of new genera and the elimination of

old ones in consequence of the necessity of founding the family Plesioporitidæ.

There are two Subfamilies—the *Lophoseridæ simplices* and *Lophoseridæ aggregatæ*.

1. Subfamily *Lophoseridæ simplices*.

I. Alliance TROCHOSERIOIDA.

Lophoseridæ with simple coralla, trochoid, turbinate, conico-cylindrical, or subturbinate. Calices shallow, rarely deep. Septa very numerous, some uniting, close, imperforate, and united by synapticula. Columella variable or absent. Pali may exist. Epitheca may or may not exist.

Genus TROCHOSERIS, Ed. & H.
Genus GYROSERIS, Reuss.
Genus TURBINOSERIS, Duncan.
Subgenus PALÆOSERIS, Duncan.
Genus PHRAGMATOSERIS, Milaschewitsch.
Genus OMPHALOPHYLLIA, Laube.
Genus PLACOSERIS, E. de From.
Genus ELLIPTOSERIS, Duncan.

Genus TROCHOSERIS, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 57 (1860), *date of description in Compt. Rend.* t. xxix. (1849).

Corallum simple, trochoid or cylindroid, adherent; wall naked, and with delicate costal striations. Calices circular, or lobed at the margin, and irregular, shallow. Columella papillary. Septa very numerous, strongly granulated laterally, uniting. Synapticula numerous.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Europe, Asia.—*Recent.* Philippines.

Genus GYROSERIS, *Reuss*; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 54 (1860).

Corallum simple, free, pedunculate, trochoid. Calice shallow, with thick margins, circular. Costal fossette large. Columella large and papiliary. Septa not exsert. Wall imperforate. Synapticula exist.

Distribution.—Fossil. Cretaceous: Europe.

The morphology of the septa separates the following genus from *Leptophyllia* and its allies, which belong to the Plesioporitidæ.

Genus TURBINOSERIS, *Duncan, Pal. Soc., Supp. Brit. Foss. Corals, Cretaceous Corals*, pt. ii. p. 42 (1870); *amended in Quart. Journ. Geol. Soc.* 1873, p. 558.

Corallum simple, turbinate, or conical, compressed a little, with a broad base, having a mark of former adhesion, or a narrow and free base. Epitheca rudimentary or absent. Calice shallow, usually elliptical. Septa numerous, solid, often uniting or not. Columella absent. Costæ well developed. Wall stout. Septa united by synapticula, and sometimes the costæ also.

Distribution.—Fossil. Lower Greensand: England. Eocene: West Indies; Sind, Asia.

Subgenus PALÆOSERIS, (genus) *Duncan, Quart. Journ. Geol. Soc.* vol. xxvi. (1870), p. 301, pl. xx. fig. 7.

Corallum simple, turbinate, and pedicellate. Calice widely open. Septa numerous, crowded, the smaller uniting with the larger, which reach the central fossula. Columella rudimentary. Synapticula numerous. Costæ covered by a complete and dense epitheca.

Distribution.—Fossil. Cainozoic, probably Miocene: Australia.

The stout epitheca distinguishes this form from *Turbinoseris*, of which it is a subgenus.

Genus PHRAGMATOSERIS, *Milaschewitsch, "Korallen der Nattheimerschicht.," Palæontographica*, xxi. (1878), p. 212.

Corallum simple, adherent, pedunculate, fan-shaped. Calice elongate. Columella absent. Septa numerous, not exsert. Synapticula exist low down in the interseptal loculi; higher up there are long, oval-outlined granules projecting from the septal lamellæ. Wall aporose, and furnished with costæ which are continuous with the septa.

Distribution.—Fossil. Jurassic: Europe.

This genus is closely allied to *Turbinoseris* (if the septa are imperforate).

Genus OMPHALOPHYLLIA, *Laube, "Die Fauna der Schicht. St. Cassian," Denks. der Kais. Akad. der Wiss. Wien*, 1864, Bd. xxiv. p. 251.

Syn. *Cnemidium*, Quenst.; *Montlivaltia*, Lam.; *Thecophyllia*, d'Orb.

Corallum simple, adherent, turbinate, cylindrical or almost

cyclolitoid in shape. Calice shallow, subplane, circular in outline. Columella styliform, prominent. The septa are numerous, close, unequal, uniting, bifurcating and trifurcating, exsert, granulate, and serrate. Epitheca strong and well developed.

Distribution.—Fossil. Trias: Europe.

Genus PLACOSERIS, *E. de Fromentel, Pal. Franç., Terr. crét. Zooph.* p. 329 (1867).

Corallum largely fixed, with a cylindrical wall. Calice round and deep. Columella elongate, and composed of a series of trabeculæ soldered together and strongly spinulose at the sides. Septa numerous, unequal, and synapticulate.

Distribution.—Fossil. Cretaceous: Europe.

In the drawing (pl. 49. fig. 4 *a*, *b*) the columella is very small.

Genus ELLIPTOSERIS, *Duncan, Fossil Corals &c. of Sind, Pal. Ind.* Ser. xiv. p. 48, pl. viii. (1880).

Corallum simple, pedunculate, conical, compressed, with a widely open elliptical calice. Columella absent. Axial space elongate and deep. Septa numerous, uniting. Pali exist on the united septa. Costæ developed. Synapticula are common. Epitheca none.

Distribution.—Fossil. Eocene: Sind.

II. Alliance CYCLOSERIOIDA.

Simple Lophoseridæ more or less discoid or plano-convex in shape, with nearly flat basal walls and numerous septa, many of which unite. Pali may occur. Columella variable. Epitheca exists or not.

Genus CYCLOSERIS, Ed. & H.
Genus DIASERIS, Ed. & H.
Genus ZITTELOFUNGIA, Duncan.
Genus BATHYACTIS, Moseley.
Genus ASTEROSERIS, E. de From.
Genus MICROSERIS, E. de From.

The genus *Tricycloseris*, Tomes, is too doubtful, and is absorbed. See E. Pratz, 'Palæontographica,' 1882.

Genus CYCLOSERIS, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 49 (1860), pl. D 12. fig. 3.

The corallum is simple, free, circular, elliptical, or angular in

outline, more or less horizontal or concave below, flat, nummiform, convex, semihemispherical above. Wall flat, costulate, imperforate. Central fossette narrow elongate or circular. Columella rudimentary or papillary, and slightly developed. Septa very numerous, uniting, denticulate at the free edge, exceedingly granular at the sides, imperforate. Synapticula abundant, and variable in their length.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Europe; Sind, Asia. Miocene: Sind, Asia.—*Recent.* Red Sea, Chinese seas, Pacific.—*Subfossil.* Red Sea.

The genus *Tricycloseris*, Tomes (Quart. Journ. Geol. Soc.), places itself in the proximity of *Cycloseris*, as the name indicates. E. Pratz remarks (Palæontographica, xxix. p. 108) that the solitary specimen of the genus may be an abnormal form, and brings before our notice that occasionally simple forms have exceptionally developed more than one calicular centre, as may be observed in *Montlivaltia* and *Omphalophyllia*.

Genus Diaseris, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 54 (1860), pl. D 12. fig. 4.

Syn. *Ecmesus*, Phil.; *Hemicyathus*, Seguenza.

Corallum simple, free, discoid, low. Wall naked and costulate, imperforate; margin lobed, irregular. In the young state composed of separate pieces or lobes which unite irregularly during growth. Septa irregular, uniting, numerous, serrate or dentate. Synapticula exist. Columella rudimentary or absent.

Distribution.—Fossil. Miocene, Pliocene: Europe.—*Recent.* Florida, Barbadoes, North Atlantic, Pacific, Australia.

Many species of *Cyclolites* were described by me in the "Fossil Corals and Alcyonaria of Sind," 'Palæontologia Indica,' Series xiv. (1880), pp. 52–55. E. Pratz considers that the forms should pass into another genus, and presumably because the septa are imperforate and there is no endotheca. Certainly now that it is clear that the typical *Cyclolites* had perforate septa and dissepiments, the species from the Eocene of Sind differ generically from it. I have founded the genus *Zittelofungia* to meet the want caused by the necessary removal of *Cyclolites* into the Plesioporitidæ.

Genus Zittelofungia, *Duncan.*

Syn. *Cyclolites*, Lmk.

Corallum free, plano-convex, circular or elliptical in outline,

with a flat or slightly concave base, and a convex calice with a circular or oval fossa. Columella absent. Septa very numerous, close, thin, unequal, uniting, crested, denticulate or moniliform at the free edge, granular at the sides, imperforate. Synapticula numerous. Dissepiments wanting. Epitheca of base in concentric folds, stout or thin.

Distribution.—Fossil. Eocene: Sind.

The genus differs from *Cyclolites*, as amended by Pratz, in having imperforate septa and no dissepiments. The species are described in the "Fossil Corals and Alcyonaria of Sind," Pal. Indica, Ser. xiv., 1880. The French Eocene *Cyclolites* probably belong here.

Genus Bathyactis, *Moseley, Report on Corals, 'Challenger' Voyage*, p. 185, pl. xi. (1881).

Syn. *Montlivaltia*, Tennison Woods; *Fungia*, Pourtalès, non Dana.

Corallum free, discoid, not attached or cup-shaped in the young condition, thin and fragile. Primary septa free, the others united so as to form six deltoid continuations. Upper margins of septa usually coalescent over the apices of the deltas. Septa deeply toothed. Synapticula sometimes abundant, sometimes few, arranged in a series of concentric circles. Columella well developed. Base costulate. No epitheca.

Distribution.—Recent. Deep water, from 30 fathoms to 3 miles, North and South Atlantic, Caribbean Sea, South-Indian Ocean, Malay Archipelago, West and East Pacific, Australian seas.

The specimens show that the columella is often reduced to the junction of septa only.

Moseley makes some most valuable remarks on the influence of growth and nutrition on the species of *Bathyactis*:—"In some specimens, dredged on a siliceous bottom composed of Diatom skeletons, the wall is excessively thin, and towards its marginal region is perforated by a series of apertures on either side of the costæ." "When a specimen hardened in spirit is decalcified, the wall of the corallum in dissolving in the acid becomes perforated by a similar series of apertures, yielding first at these spots."

Genus Asteroseris, *E. de Fromentel, Pal. Franç., Terr. crét.* tom. viii. p. 328 (1867).

Syn. *Stephanoseris*, E. de From., non Ed. & H.

Corallum hemispherical, with an imperforate basal plateau, which is discoid and covered with granulations which are in radiating lines near the edge. Columella slightly developed, and reduced to three or four slightly visible points. The septa are large, unequal, and strongly granulated where free. Pali well developed before the tertiary septa. Synapticula present.

Distribution.—Fossil. Cretaceous: Europe.

M. de Fromentel does not say anything about the dissepiments or the condition of the septa.

Genus Microseris, *E. de Fromentel, Pal. Franç., Terr. crét.* No. 23 (1870), p. 367.

Corallum hemispherical. Wall horizontal, naked, and covered with sparsely distributed granulations which do not simulate costæ. Septa large, arched, uniting in joining at the centre of the calice, where there is a little rounded fossula. Synapticula rare, but well developed.

Distribution.—Fossil. Cretaceous: Europe.

This genus requires further consideration.

III. Alliance PSAMMOSERIOIDA.

Simple Lophoseridæ with the base containing a Sipunculid worm or growing on univalve shells, low. Penultimate septa well developed. With or without pali. No epitheca.

Genus Psammoseris, Ed. & H.
Genus Stephanoseris, Ed. & H.

Genus Psammoseris, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 55 (1880), pl. x. figs. 9, 9*a*; *Ann. des Sci. Nat.* 1848–49, *Zool.* tom. 9; *amended.*

Corallum simple, low; base broad, containing a Sipunculid worm; sides perforated with several apertures. The wall is thick, naked, strongly granulate, and barely striated below, costulate elsewhere. Calice circular. Columella spinulose, papillary. Septa low, thick, close, granular; primaries and secondaries longest and largest; the septa of the fourth cycle next in length, and uniting axially in front of the tertiaries.

Distribution.—Recent. Chinese seas, Malacca.

Genus Stephanoseris, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 56 (1860).

The corallum is short, with an unsymmetrical tumid base, which is larger than the calice. Base containing a Sipunculid worm, and perforated with large and small apertures, or fixed on a Gastropod shell. Calice circular or subcircular, open. Septa numerous, well developed, arched, tall, subentire, denticulate axially. Septa of first and second orders tallest; those of last cycle close to and nearly as high as their neighbours of the earlier cycles. Pali before all septa except the last cycle, small, arched. Columella trabeculate, and minutely papillary at the surface. Costæ large, unequal, granular, with deep narrow intercostal spaces. Underpart of base smooth or granular, not costulate except at the edge. Wall very thick, solid. Granules on septa numerous, elongate, radiating.

Distribution.—Recent. Indian Ocean, Corean sea, Philippines, Zanzibar.

This last genus was placed by Gray amongst the Heterocyathi, and separated by Jules Haime on account of its internal structures. I place it here with much doubt; for I have not found synapticula in any specimens, and the details of the soft parts are not known. Indeed this Alliance is unsatisfactorily placed, and requires greater revision than materials will at present permit of.

IV. Alliance PODOSERIOIDA.

Simple Lophoseridæ with a wide base of attachment. Calice convex, with a central fossula. Costæ distinct, and covered or not with epitheca.

Genus Podoseris, Duncan.
Genus Episeris, E. de From.

Genus Podoseris, *Duncan, Supp. Brit. Foss. Corals, Pal. Soc. Lond.* Pt. ii. No. 1, p. 25 (1869), *amended in* Pt. iii. p. 24.

The corallum has a wide or pedunculate base of attachment; the height varies, but the calice is generally narrower than the base, and is convex. Its central fossula is circular and small. The columella is formed by the septal ends; and the septa are numerous, close, unequal, uniting. The costæ are distinct, straight, and covered more or less by epitheca. Synapticula numerous.

Distribution.—Fossil. Oolite and Cretaceous: England.

Genus Episeris, *E. de Fromentel, Introd. à l'étude des Polyp. foss.* p. 123 (1859).

Corallum tall, at first horizontal and then cylindrical. Epitheca strongly developed and folded. Septa very exsert, finely dentate. Columellary fossula very elongate.

Distribution.—Fossil. Cretaceous : Europe.

The typical species, *Episeris macrostoma*, is a very large coral, and is not without its affinities with *Podoseris*, nobis.

Group-Genus Gonioseris, *Duncan.*

Genus Gonioseris, *Duncan, Pal. Soc., Supp. Brit. Foss. Corals*, Ser. 2, Pt. iii. p. 21, pl. vii. (1872).

Corallum simple and free. Base polygonal, projecting angles formed by groups of costæ ending in septa. Margin concave between the angles. Centre of base concave. Costæ numerous, covering the base and converging in groups at each angle along a line leading from a large septum to the centre. Upper surface convex, divided by masses of septa continuous with the costæ from the base of the angles. They are exsert externally, and reach the axial space, where they meet. There is a large prominent primary septum in each mass. The calicular wall is not seen from without. Synapticula broad and numerous.

Distribution.—Fossil. Inferior Oolite · England.

2. Subfamily *Lophoseridæ aggregatæ.*

I. Alliance CYATHOSERIOIDA.

Colonial Lophoseridæ, trochoid or depressed turbinate in shape. Common wall naked and costulate. Calices superficial, radiating, and with confluent septo-costæ.

Genus Cyathoseris, Ed. & H.
Genus Crateroseris, Tomes.
Genus Thamnoseris, Etallon.

Genus Cyathoseris, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 59 (1860).

Colony trochoid, adherent. Calices superficial and tolerably distinctly radiating. Septa long, thick, granulate laterally and confluent. Columella papillary or rudimentary. Wall of the colony naked and striated, and sometimes folded so as to

produce lobes or collines at the articular surface. Synapticula exist.

Distribution.—Fossil. Cretaceous: Europe. Eocene: Europe, Asia.

Genus Crateroseris, *Tomes, Quart. Journ. Geol. Soc.* vol. xxxix. p. 560 (1883).

Corallum composite, massive, depressed turbinate; calicular surface superior and convex. There is a common wall which is naked and costulated. The calices are evenly distributed, round and prominent, but depressed in the middle; and they have a well-defined fossula. The intercalicular spaces are depressed. The septa are imperforate; margins moniliform and continuous with septo-costæ, which pass from one calice to another without interruption. Septa and septo-costa have synapticula attached to them. Increase by gemmation between the calices at the outer margin.

Distribution.—Fossil. Portland Oolite: England.

No section is given of this form; and in the description of the species the synapticula are said to be rather small.

There is some doubt about the next genus, and regarding its proper alliance. M. de Fromentel notices ('Introd. à l'étude,' p. 241) a species of a genus called *Thamnoseris* which had been communicated to him by Etallon; and this author remarks on M. de Fromentel, and gives a correct generic diagnosis of the genus in his 'Lethæa Bruntrutana,' Zurich, 1864, p. 406.

Genus Thamnoseris, *Etallon, Lethæa Bruntrutana,* p. 406 (1864).

Colony in rounded masses or in thin laminæ. Epitheca thin and complete. Columella papillary. Septa confluent, thick, covered on their free edge and flanks with very projecting granules which are close together, and constitute more or less numerous synapticula.

In a description of a species, *Thamnoseris Froteana*, Etallon, *op. cit.* p. 406, pl. lvii. fig. 10, it is stated that the corallum is conical and turbinate, with growth-rings on the inferior plateau, and sometimes even on the circumference of the corallum. Upper surface subplane, or a little convex and irregular. Calices subequal, usually polygonal, with a well-marked centre. Septa unequal according to the orders, of slightly different thickness;

three cycles and part of the fourth. Synapticula rare. Columella fasciculate, vermiculate, and distinct.

The delineation of the species is a mere sketch; but it shows that the calices are close and separated by a mere ridge, over which, from the description, we may presume the septa are confluent with their neighbours. The calices are deepish.

Now in the species noticed by De Fromentel the calices are also deep; the septa are confluent and in bundles. Neither Etallon nor De Fromentel writes anything about the structure of the septa, whether they are perforate or merely trabeculate or solid.

Etallon lays stress on the fact that there are no dissepiments between the septa.

The generic diagnosis might now be stated as:—

Colony variable in shape, amorphous and convex, turbinate and conical, or in lamellæ. Corallites low and small, polygonal, close. Calices rather deep, polygonal, separated by narrow margins, over which the septa pass. Columella fasciculate and papillary, fused. Septa in three or four incomplete cycles, well-developed, often uniting, thickish, but diminishing in width in the higher orders, granulate on the free edge and on the flanks, close. Synapticula small, variable in number. Dissepiments wanting. Epitheca exists; and it and the colony may be marked with growth-rings.

Distribution.—Fossil. Jurassic: Europe.

II. Alliance PAVONIOIDA.

Colonial Lophoseridæ in thin, frondiform, curled, adherent laminæ, crested or not. With an imperfect or synapticulate calicular wall. Calices numerous, distinct or indistinct; on one or on both sides of the fronds. Collines or crest-like ridges exist. Septa occasionally more or less trabeculate and perforate, or solid.

Genus Lophoseris, Ed. & H.
Genus Tichoseris, Quelch.
Genus Mycedium, Oken.
Genus Phyllastræa, Dana.
Genus Trachypora, Verrill.
Genus Leptoseris, Ed. & H.
  Subgenus Haloseris, Ed. & H.
Genus Protoseris, Ed. & H.
  Subgenus Phylloseris, Tomes.
Genera absorbed:—
  Pavonia, Lamarck; Echinophyllia, Klunzinger.

Phylloseris, Tomes, and *Haloseris*, Ed. & H., become subgenera.

Genus Lophoseris, *Milne-Edwards & Jules Haime*, 1849; *Lamarck, Hist. Anim. sans Vertèb.* t. ii. p. 238 (1816); *amended Journ. Linn. Soc., Zool.* vol. xvii. (1883), p. 313, pl. xiii. figs. 7–12.

Syn. *Pavonia*, Lmk.

Colony adherent, thin, foliaceous, erect, in lobes or crests, irregular in shape, with radiating calices, confluent by their septo-costæ; on one or both surfaces and between and on low crests placed more or less vertically, over which septo-costæ pass. Columella tubercular or rudimentary, deep. Common plateau naked and striated. Septa solid or trabecular in parts. Calices rather elongate, circular when young, surrounded by a wall or by synapticula fused into a mural condition. Synapticula well developed, and distinguishable from ornamental granulation. Gemmation occurs between the calices and amongst the septo-costæ.

Distribution.—Recent. Pacific, from west coast of America to Australia, east of China, Japan, Hong Kong, Indian Ocean, Red Sea, Burmese seas.

Verrill states that it does not exist in the Atlantic.

Subgenus Haloseris, (genus) *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 77 (1860); *L. Rousseau, Voy. au Pôle Sud* (1834).

Colony fixed, forming small frondescent folded laminæ, much incised at the edges, and crispate. Calices indistinct on the internal surface, which is covered with very long septo-costal rays, which are very granulated. Columella rudimentary. External surface delicately striated. Synapticula exist.

Distribution.—Recent. Philippines.

Genus Tichoseris, *Quelch, Ann. & Mag. Nat. Hist.* 1884, vol. xiii. p. 295.

Corallum compound, massive, columnar or lobate, with neither transverse calicinal ridges nor longitudinal crests, astræiform. Calicles with distinct solid walls, which are thin at their edges but thick at their basal parts; calicinal centres arranged either singly within their own wall, or united in more or less irregular and sinuous groups of two or more, incompletely separated from each other and surrounded by the common wall of the calicle from which they are developed. New calicles arise either by

direct fission of a single calicle forming two separate ones with distinctly raised walls, or by the upgrowth of the synapticula at different parts of the calicle to form new walls, the resulting centres often forming mæandroid series, until the development of their own wall isolates them. Septa not at all confluent, entire, those of adjoining calicles quite separated by the raised walls. Columella absent or forming a very small styliform projection at the point of coalescence of the septa. Synapticula distant, very unequally and irregularly developed, being generally rather thick interseptal outgrowths of the wall.

Distribution.—Recent. Fiji Islands.

Genus MYCEDIUM, *Oken, Lehrb. der Natur., Zool.* 1815; *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 72 (1860), pl. D 12. fig. 2; *Pourtalès, Deep-Sea Corals,* p. 48.

Colony frondiform. Calices well developed, circumscribed, usually a central one surrounded by concentric series of others, inclined and submammillate, projecting or flat. Columella variable, papillary, compressed, tubercular, or absent. Septo-costæ long, continuous. Synapticula exist. Common under-surface naked and variably costulate.

Distribution. — Recent. Caribbean Sea, East-Indian seas, Pacific.

Reuss noticed the genus in the Eocene, but probably the form was a *Thamnastræa.*

The variation in the species of this genus has been commented upon by Pourtalès, and it is evident that it is but slightly removed from *Lophoseris.*

Dana introduced the genus *Phyllastræa* to include *Mycedium Okeni.*

Genus PHYLLASTRÆA, *Dana, Zoophytes U. S. Explor. Exped.* 1846, p. 40; see *Hist. Nat. des Corall.* vol. iii. p. 75, pl. D 12. fig. 1.

Syn. *Oxypora,* Kent.

Colony foliaceous; polypes prominent and opening upward. Coralla striated, scarcely echinulate. Costal striæ coarse, unequal and scabrous. Calicles large, margins projecting, and attached laterally to the folia. Septa thin and spinulose. Columella spongy.

Distribution.—Recent. Amboyna, Pacific.

Genus Trachypora, *Verrill, Bull. Mus. Comp. Zool.*, Camb. Mass., 1864, No. 3, p. 53.

Syn. *Echinophyllia*, Klunzinger, Corall. des Roth. Meer. p. 69 (1879).

Colony explanate, thin; below echinate and coarsely costate; above with scattered polyp-centres destitute of walls, with one or two cycles of septa radiating at the centres, but becoming subparallel between them, as in *Halomitra*, strongly dentate or lacerately lobed. The strongest lobes surround the polyp-centres. Columella loose, trabecular.

Distribution.—Includes *Echinopora aspera*, Ellis and Solander, of the East Indies.

Klunzinger places the genus between *Halomitra* and *Mycedium* and *Echinopora*. It looks like a Thamnastræan amongst the *Echinoporæ*.

Genus Leptoseris, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 76 (1860).

Colony adherent, in very thin laminæ, often folded or irregularly twisted, pedunculate or not. Calices not numerous; a large central one surrounded by small ill-defined but radiating concentric calices. Septo-costæ very long. Columella tubercular. Beneath, the surface is naked and delicately striated.

Distribution.—*Recent.* Ile de Bourbon.—? *Fossil.* Eocene: Europe.

The genus *Protoseris*, Milne-Edwards & Jules Haime, Brit. Foss. Corals, Oolitic (Pal. Soc. Lond. 1851), p. 103, tab. xx., is clearly closely allied to *Lophoseris*, Lamarck (1816). The distinction is the papillary columella, for the frondescent shape is found in *Lophoseris*. In this last genus the columella is tuberculous or rudimentary. It is interesting to find the genus *Lophoseris* foreshadowed in the Jurassic age.

Genus Protoseris, *Milne-Edwards & Jules Haime.*

Colony foliaceous, ascending, folded, and lobed, more or less funnel-shaped. Calices superficial and distant, separated neither by crests nor by ridges. The columella is papillary. The septa are flexuous and confluent. The lower surface of the laminæ is costulate and without epitheca. Synapticula exist.

Distribution.—*Fossil.* Jurassic: England.

Subgenus PHYLLOSERIS, (genus) *Tomes, Quart. Journ. Geol. Soc.* vol. xxxviii. p. 447 (1883).

Differs according to its describer wholly in the way in which the fronds are produced (? developed), and in the presence of a strongly developed epitheca, from *Protoseris*. The only distinction is the presence of an epitheca, which is not generic. Hence the species *Phylloseris rugosa*, Tomes, must come within the scope of the genus *Protoseris*. I place *Phylloseris* as a subgenus of *Protoseris*. Its sole locality is in the Lower Oolite of England.

III. Alliance STEPHANARIOIDA.

Colonial Lophoseridæ, massive, incrusting, or lobate and subdendroid. Septo-costæ confluent and well developed. Walls absent or indistinct. No collines.

Genus STEPHANARIA, Verrill.
Genus PRATZIA, Duncan.

Genus STEPHANARIA, *Verrill, Trans. Connect. Acad.* i. p. 340 (1867).

Colony in short lobe-like branches. Calices moderately large, with two or three cycles of septa, denticulate on the edge, well developed and confluent. Walls indistinct or wanting; the division between the calices indicated only by small granular points, which sometimes interrupt the septa of adjoining calices. Columella papillose. Paliform papillæ before all the principal septa, the inner ones becoming confounded with the columella.

Distribution.—Recent. West-American coast.

Genus PRATZIA.

Syn. *Plerastræa*, Duncan, Foss. Corals &c. of Sind, 1880, p. 65, Pal. Indica, Ser. xiv.

The colony is massive, incrusting. Calices superficial. Columella substyloid, produced by the septal ends. Septa solid, arranged in several lozenge-shaped or triangular groups, confluent, crowded. Walls absent. Synapticula abundant, close, and reach high up in the interseptal loculi. Endotheca absent. Epitheca absent.

Distribution.—Fossil. Eocene of Sind, Asia.

IV. Alliance AGARICIOIDA.

Colonial Lophoseridæ, foliaceous or massive, or incrusting. Calices distinct or indistinct, in series separated by collines. Septo-costæ confluent and extending over the collines.

Genus AGARICIA, Lamarck.
Genus PLESIOSERIS, Duncan.
Genus PACHYSERIS, Ed. & H.
Genus COMOSERIS, d'Orb.
Subgenus OROSERIS, Ed. & H.
Genus HYDNOPHORABACIA, d'Achiardi.
Genus COSCINARÆA, Ed. & H.

The genus *Oroseris* becomes a subgenus.

Genus AGARICIA, *Lamarck, Syst. des Anim. sans Vertèb.* (1801); *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 80 (1860).

Syn. *Undaria*, Dana.

Colony foliaceous and irregular in shape. Calices on one or both surfaces, circumscribed or limited at least on two sides, in transverse or concentric series, which are separated by unequal ridges (collines), over which the confluent septo-costæ pass. Columella tuberculous, papillose, or compressed. Septa confluent, not numerous. Common plateau striated and naked. Synapticula exist.

Distribution.—Fossil. Miocene of Sind, Asia; Europe.—*Subfossil.* Red Sea.—*Recent.* Caribbean Sea, Indian Ocean, Red Sea.

Genus PLESIOSERIS, *Duncan, Journ. Linn. Soc., Zoology*, vol. xvii. p. 309 (1883).

Syn. *Mæandroseris*, Rousseau (pars).

Colony massive, adherent, and without epitheca. Surface irregular and nodular. Calices in short series, confluent by their septo-costæ and with distinct centres. Septa often uniting, solid, except near axial space, where they are trabeculate with ascending processes; granular on the sides, warty and spinulose on the free edges. Columella well developed and papillary. Synapticula of two kinds:—1, long, broad, and vertical, in two rows near the true calicular wall; 2, small and nodular, near the axial space. Eminences between the series of calices covered by septo-costæ, and having a true wall. Growth by gemmation beyond and between the calices.

Distribution.—Recent. Pacific.

This genus, characterized by its solid septa, walls, and synapticula, and serial calices, includes *Mæandroseris*, now *Plesioseris, australiæ*, Rousseau, sp.

Genus PACHYSERIS, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 85 (1860); *Duncan, Journ. Linn. Soc., Zool.* vol. xvii. p. 309 (1883), *and Pal. Indica*, Series xiv. *Foss. Corals &c. of Sind*; *amended.*

Colony adherent, foliaceous, very variable in shape. Base a thin solid wall, which is costulate. Upper surface presenting long concentric eminences or collines and intermediate valleys, the first crossed by parallel septo-costæ, the latter showing an axial space, with or without a projecting columella close to the end of the septa. No distinct calices or radiating series of septa. The series of septa in the valleys are long and very bifurcate. Columellary space very long and filled up by series of tabulate dissepiments. Septa close, finely dentate and granular on their sides, rarely perforate. Synapticula long vertically, and occupying the position of a colline-wall, and small and nodular, and placed on the septa close to the columellary space.

Distribution.—Fossil. Lower Eocene of Sind, Miocene of Sind. —*Recent.* Pacific and Indian Oceans.

Genus COMOSERIS, *d'Orbigny, Note sur les Polyp. foss.* p. 12 (1849).

Colony thick, attached or free, base covered with a stout epitheca. Upper surface with calices more or less close, distinct at their centres, and with confluent septa, separated at certain points by collines, over which the septo-costæ pass. Collines long or short, narrow or broad, straight or curved, radiating from the centre of the upper surface or not. A rudimentary columella. Septa united by synapticula. No wall around the calices or in the collines. A basal wall, which is solid and marked with costæ, underlies the dense epitheca.

Distribution.—Fossil. Jurassic: Europe. Cretaceous: India.

There is a very fine specimen of *Comoseris irradians*, Ed. & H., in the Museum of the Geological Survey in Jermyn Street, which shows the construction of the septa and synapticula very well. The septa are slender, trabeculate, but imperforate, and there are the same kind of endothecal processes as are seen in *Thamnastræa*.

The epitheca is worn off, and the striated, costulate, basal wall

is well shown; it is imperforate. Before *Thamnastræa* was shown to have synapticula, the distinction of the two genera was evident, and *Comoseris* was the solitary example of a fossil Fungid with confluent calices and an epitheca. It is now closely allied to the endothecate *Thamnastrææ*, the sole distinction being the presence of collines in *Comoseris*.

In introducing several new species of *Oroseris* to the Oolitic coral-fauna of England, Mr. R. Tomes, F.G.S., asserts (Quart. Journ. Geol. Soc. vol. xxxviii. p. 440) that the genus really bears but a faint resemblance to the genus *Comoseris*. He seems to have misunderstood the diagnoses of the genera, for it must appear on reading them that *Oroseris* can hardly stand as a genus distinct from *Comoseris*. The only distinction is the length of the ridges bounding the calicinal valleys.

In many parts of the corals of both genera, there are no ridges for a certain space, every calice not being thus separated, so that such areas dismembered would resemble species of *Thamnastræa*. It is this fact which brings the forms so closely together. The presence of the ridges or collines, so continuous in the species, cannot be put on one side in classification, and especially in the face of the allied genera *Mæandroseris* and *Plesioseris*.

In placing *Oroseris* as a subgenus of *Comoseris* it must be admitted that the first-named form has a more varied shape than was given to it by Milne-Edwards and Jules Haime. Mr. Tomes has delineated an incrusting form and a semi-massive, irregular one, and also a species massive and with a lobed outline. He has shown also that the epitheca may be strong and wrinkled, indeed as much so as in *Comoseris*.

Subgenus Oroseris, (genus) *Milne-Edwards & Jules Haime*, *Pol. Foss. des terr. Pal.* p. 130 (1851).

Colony in rather thin laminæ, and the basal wall is either naked or covered with a rudimentary, or strong and wrinkled epitheca. The calices are subconfluent and separated irregularly by transverse subcristiform eminences (collines), which usually, but not invariably, limit simple series of calices and do not extend the length of the colony. The columella is rudimentary.

Distribution.—Fossil. Jurassic: England, Europe. Neocomian?: Europe. Cretaceous: England. Eocene: Europe. Miocene of Italy.

Genus Hydnophorabacia, *d'Achiardi, Corall. Eocenici del Friuli, Pisa*, 1875, p. 72, tav. xiii. figs. 3, 4, 5.

Colony frondiform. Calices distributed over the upper surface and having conical eminences between them. Septa confluent, granular where free. Columella papillary. Synapticula well developed. Base of colony echinulated and finely vermiculate.

Distribution.—Fossil. Eocene: Europe.

There is an undescribed genus, represented by two specimens in the British Museum, in which the collines are irregular, longer than in the above, covered by close septa-costæ. The columella is styliform. Colony massive. It is clearly allied to the above, but yet distinct.

Genus Coscinaræa, *Milne-Edwards & Jules Haime, Monogr. des Poritides*, p. 48; *Compt. Rend.* t. xxvii. p. 496 (1848); *amended*; *Duncan, Journ. Linn. Soc., Zool.* vol. xvii. p. 314 (1883).

Colony massive, partly incrusting, convex above, with irregular-shaped, rather deep calices in short series, with slightly projecting intermediate eminences. Calicular centres usually distinct; septa uniting with those of neighbouring calices and extending over the eminences. Some septa are simple and others unite by their sides with larger ones; spinulose at the free edge, perforate and trabeculate, except near the solid basal wall, which is very thin and costulate. Columella deep, small and papillary. Synapticula more or less in vertical series, discontinuous and stout. No walls between the calices. Gemmation between the calices, on the eminences, and intervening spaces.

Distribution.—Fossil. Cretaceous: India?—*Recent.* Red Sea; Mauritius; Burmese seas.

A careful examination of numerous specimens of species in the British Museum and in my own collection, has not enabled me to discover endothecal dissepiments. Milne-Edwards and Jules Haime drew them, but Klunzinger's photographs do not show them. Probably the stereoplasm-looking endotheca in Milne-Edwards's plate is the result of irritation from parasitic growth. The thin basal wall in the specimens from Mergui resembles epitheca more than theca.

IV. Family ANABACIADÆ.

Madreporaria Fungida simple or colonial. Septa trabeculate and fenestrated. Synapticula small. Dissepiments absent. Wall indistinct.

Genus ANABACIA, d'Orb.
Genus GENABACIA, Ed. & H.

Genus ANABACIA, *d'Orbigny*, *Note sur les Polyp. foss.* p. 11 (1849).

Corallum simple, free and without a trace of adherence, plano-convex or biconvex in shape. The upper surface has a central shallow fossette without a true columella. The septa are very numerous, close, uniting, and are continued over the edge to the base, where their free edges are in the position of costæ. They extend from the base vertically to the upper surface, are trabeculate and perforate, and delicately spined or crenulate at their free edge. There is no basal wall, and the septa unite by synapticula.

Distribution.—Fossil. Jurassic: England and Europe.

Genus GENABACIA, *Milne-Edwards & Jules Haime*, *Compt. Rend. Acad. des Sci.* t. xxix. p. 71 (1849).

Colony sublenticular, base naked and perforate. A central calice surrounded by one or two circles of smaller size with confluent septo-costæ. Septa trabeculate, perforate, thin, close rather numerous, crenulated where free. Calicular fossette not, deep. No basal wall.

Distribution.—Fossil. Middle and Inferior Oolite: Europe.

Transitional group.

V. Family PLESIOPORITIDÆ.

Fungida with trabeculate and regularly perforate septa. Synapticula between the septal laminæ in the interseptal loculi. Sclerenchyma trabeculate. Dissepiments may or may not exist. Wall existing or not, and imperforate. Epitheca may exist and be well developed.

Alliances.

I. LEPTOPHYLLIOIDA.
II. MICROSOLENOIDA.
Groups CYCLOLITES and MYCETARÆA.

I. Alliance LEPTOPHYLLIOIDA.

Simple Plesioporitidæ, turbinate, conico-cylindrical, fixed or not. Epitheca present or absent. Septa very numerous, trabeculate, perforate, uniting, joined by synapticula.

Genus LEPTOPHYLLIA, Reuss.
Subgenus THECOSERIS, E. de From.
Subgenus TROCHARÆA, Etallon.

The genera *Thecoseris* and *Trocharæa* become subgenera; *Haplaræa* is not placed.

Genus LEPTOPHYLLIA, *Reuss, Denkschr. der Wiener Akad. der Wiss.* t. vii. p. 101 (1854); *Pratz, Palæontographica*, p. 90 (1882).

Syn. *Haplaræa*, Milas.

The corallum is simple, fixed, and pedunculated; the wall is naked and marked with close costæ, which are numerous and granular. The calice is circular or subovular or elliptical in outline. The columella is absent. The septa are very numerous, close, thin, often uniting, and are composed of vertical trabeculæ with vertical rows of perforations between them. Synapticula occur in abundance, and are found high up in the interseptal loculi. Dissepiments occur in the interseptal loculi. Epitheca absent.

Distribution.—Fossil. Jurassic, Cretaceous: Europe.

It is not possible to retain the genus *Haplaræa*, as its distinction from *Leptophyllia* is having an epitheca, and this is not generic in importance.

Subgenus THECOSERIS, (genus) *E. de Fromentel, Pal. Franç., Zooph., Terr. crét.* p. 367 (1869).

Corallum elevated and regularly turbinate. Calice concave, and the fossa round. Septa thin, numerous, not exsert, often anastomosing and finely denticulated, the larger usually meeting in the centre of the calice and forming a false columella. Wall thin, costæ numerous, covered to the margin of the calice by a strong folded epitheca. Synapticula feebly developed.

Distribution.—Fossil. Oolitic: England. Cretaceous: Europe, India.

Subgenus TROCHARÆA, (genus) *Etallon, Lethæa Bruntrutana* (Zurich, 1864), p. 411.

Corallum simple, largely fixed, having the structure of *Microsolena*. It approaches the genus *Anabacia*, but has more distinct (latticework-like) septa and is broadly adherent. No epitheca.

The species described and delineated by Etallon (*op. cit.* p. 411, pl. lviii. fig. 4) is *Trocharæa actiniformis*. A small short corallite, cylindrical, and hemispherical above, largely fixed, the base being broader than the calice. Calicinal central fossette narrow and deep. Septa latticework-like, stout, in five cycles, the last being more or less incomplete. Columella indistinct. Height 7 millim.

Distribution.—Fossil. Jurassic: Europe.

I give the diagnosis of *Haplaræa*, but do not place the genus.

Genus HAPLARÆA, *Milaschewitsch, Nattheim. Korallen*, Abtheil. ii., *Palæontographica*, xxi. p. 228 (1875).

Corallum simple, cylindrical, tall, deeply indented with broad circular growth-rings, and furnished with a smooth epitheca (here and there). The calice is shallow and elliptical. There is no columella. The septa are very numerous, well developed, and perforated by large apertures distributed without order. The younger septa unite with the others, and all are united by numerous well-developed synapticula.

Distribution.—Fossil. Jurassic: Europe.

Group-Genus CYCLOLITES, Lamk.

Genus CYCLOLITES, *Lamarck, Syst. des Anim. sans vertèb.* p. 369 (1801); *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 37 (1860); *E. Pratz, Palæontographica*, xxix. 1882, p. 7, Taf. xiv. figs. 1–8; *amended.*

The corallum is simple, free, circular, elliptical, or slightly angular in outline, flat or slightly concave at the base, where there is a well-developed concentrically folded epitheca, convex more or less above. Fossula circular or elongate. Columella

rudimentary or absent. Septa very numerous, close, unequal, often uniting, denticulate where free, trabeculate in construction, with regular nodules, partly solid and often perforate, then forming a latticework. Synapticula feebly developed, or elongate and visible. Dissepiments exist.

Distribution.—Fossil. Jurassic, Cretaceous: Europe, India.

II. Alliance MICROSOLENOIDA.

Colonial Plesioporitidæ, polymorphous, massive, dendroid, lobed or subplane. A wall often present, with costæ. Septa trabeculate and perforate. Synapticula present.

Genus MICROSOLENA, Lamour.
Genus POLYPHYLLOSERIS, E. de From.
Genus THAMNARÆA, Etallon.
Genus DIPLARÆA, Milas.
Genus DISARÆA, E. de From.
Genus DIMORPHARÆA, E. de From.
Genus LATIMÆANDRARÆA, E. de From.
Genus MEANDROSERIS, Rousseau.

The genera DENDRARÆA, d'Orb., ACTINARÆA, d'Orb., DIMORPHOSERIS, Duncan, and MEANDRARÆA, Etallon, are absorbed.

Genus MICROSOLENA, *Lamouroux, Exp. Méthod. des genres des Polyp.* p. 65 (1821); *amended.*

Syn. *Dendraræa*, d'Orb.; *Actinaræa*, d'Orb.

Colony massive, polymorphous, mamilliform, conical, with a broad base, nearly spherical, turbinate and pedunculate, and lobed, gibbous, lamelliform, or digitiform and subramose. Basal wall with delicate costæ covered with a strong epitheca. Calices shallow, close or distant without order. Septo-costæ straight or curved, delicate, close, confluent, in groups or not, minutely pointed with small spinules above, and formed by vertical trabeculæ swollen regularly and forming a regular latticework of perforations. Columella very small or absent. Synapticula abundant, small. No calicular walls.

Distribution.—Fossil. Jurassic: England, Europe. Trias: ? Europe.

Genus POLYPHYLLOSERIS, *de Fromentel, Pol. Foss. de l'étage Néocomien*, p. 67 (1857).

Colony massive and convex. Corallites united by a costal

development. Calices circular on dome-like projections, with a central, circular, well-marked fossette. The septa are numerous, toothed, uniting and joined by well-developed synapticula. The basal epitheca well developed, and hiding delicate and numerous costæ.

Distribution.—Fossil. Cretaceous: Europe.

Genus THAMNARÆA, *Etallon, Lethæa Bruntrutana,* p. 411 (1864).

Colony branched or elongate, dense, strongly perforate as if vermiculate. Calices superficial. Columella sometimes tubercular. Septa confluent, irregular, more or less bent and echinulate (perforate in the delineation). Wall absent. Synapticula?

Distribution.—Fossil. Jurassic: Europe.

This genus, with a very Microsolenian facies, is allied to the Perforate genus *Psammocora* by Etallon. E. Pratz places it, however, in the neighbourhood of *Microsolena.*

Genus DIPLARÆA, *Milaschewitsch, Nattheim. Korallen,* Abth. ii., *Palæontographica,* xxi. p. 299 (1875).

Colony dendroid, with a broad basal stem; branchlets more or less vertical. Calices more or less oval in outline, rounded off at the margin, and shallow. Columella spongy. Septa numerous, anastomosing, thick at the wall, thin near the centre of the calice; they are perforate near their inner ends. Synapticula well developed.

Distribution.—Fossil. Jurassic: Europe.

The illustration shows costæ, and probably there was an epitheca.

Genus DISARÆA, *de Fromentel, Introd. Polyp. foss.* p. 245 (1858–1861).

The colony is branched and in low bush-shaped forms, and the corallites arise low in the primary stem, and grow upwards, not separating much. There is no wall to the corallites, and the calicinal parts are convex and rounded, the calices having a circular fossette in their axis. The septa are very numerous and delicate, being composed of nodules and processes, the first being joined to the corresponding structures of the neighbouring septa. The costæ are covered with a delicate epitheca.

The author of this genus states that the internal construction

of the corallum closely resembles that of *Microsolena*. Gemmation occurs on the margin of the calices or within them.

Distribution.—Fossil. Jurassic: Europe.

Genus Dimorpharæa, *de Fromentel, Introd. Polyp. foss.* p. 254 (1858–61).

Syn. *Dimorphoseris*, Duncan.

Colony polymorphous in a convex mass, or laminate. Calices shallow, a central larger one surrounded by others placed circumferentially. Septo-costæ continuous from the central calice to the others and between them. Septo-costæ numerous, and close or few. Free edge of the septa minutely punctate, and the rest of the structure as in *Microsolena*. An epitheca.

Distribution.—Fossil. Jurassic: England, Europe.

Genus Latimæandraræa, *de Fromentel*, 1856, *Introd. Polyp. foss.* p. 247 (1858–61).

Syn. *Meandraræa*, Etallon.

Colony in a lobed and subplane form (laminate). Calices not very deep, distinct, and situated between rather high collines with rounded tops. Septa trabecular, spinulose, and confluent. Wall absent. Columella rudimentary. A thin but well-developed epitheca.

Distribution.—Fossil. Corallien of England, Europe.

The founder of this genus states that the septa resemble those of *Microsolena*, Lamouroux, and *Disaræa*, de Fromentel.

It appears that in some species the valleys are long, twisted at the centre, and straight at the circumference of the colony. The septo-costæ pass over the collines except in one instance, *L. Cotteaui*, E. de From., which is exceptional.

Genus Meandroseris (pars), *L. Rousseau in d'Urville's Voy. au Pôle Sud*, t. v. p. 121, *amended.*

The colony is partly adherent and rather thick, has a basal imperforate costulate wall, which is naked and more or less sublobed. The calices are shallow, distinct, and are grouped in long or short linear series, which are separated by low collines or eminences. Septa extend from one calice to another and over the eminences, are dentate, trabecular, and perforate; perforation less low down. Columella small and papillary. Eminences low, long or short, and more or less radiating from the

centre. Synapticula, both small and large, occupying the place of a corallite-wall, and of that of the eminences also. Gemmation between the calices.

Distribution.—Recent. Red Sea, Indian Ocean.

This diagnosis refers to *Meandroseris* so far as it includes *M. Bottæ.*

Group-Genus Mycetaræa, Pratz.

Genus Mycetaræa, *Pratz, Palæontographica,* xxix. Band, Lieferug 2, p. 111 (1882).

Corallum simple, or composed of two or more confluent calices, growing in a succession of alternating oval, irregularly trochoid to cylindrical shapes. The young individuals either remain united close to the parent as they grow, or become separated and distinct in the upper portion, forming angular projections. Epitheca exists. Septa projecting, numerous, finely toothed, subequal, and built up of regular series of trabeculæ. Intertrabecular areas slightly or not filled in. Septal laminæ united by more or less regular synapticula.

Distribution.—Fossil. Jurassic: Europe.

CHAPTER VI.

The Section Madreporaria Perforata, definition, and families. Family Eupsammidæ, alliances and genera. Family Madreporidæ, alliances and genera. Family Poritidæ, alliances and genera.

III. Section MADREPORARIA PERFORATA, *Ed. & H.*

This section is thus described in the Hist. Nat. des Corall. vol. iii. p. 88, 1860, and was established in 1850.

" Corallum entirely or almost entirely composed of porous or reticulate cœnenchyma. Septal apparatus well characterized and primitively composed of six elements, but sometimes being represented only by series of trabeculæ. Dissepiments rudimentary. Tabulæ absent."

This definition is correct as far as the end of the last sentence but one; but it requires some additions and alterations.

Section MADREPORARIA PERFORATA, *Ed. & H., amended.*

Corallum composed entirely or nearly entirely of porous or reticulate cœnenchyma. Visceral cavities intercommunicating, and not shut off from the surrounding medium. Septa either well developed, solid or slightly or much perforated, or represented by trabeculæ only. Dissepiments may or may not exist, and tabulæ also. Soft parts filling the porose sclerenchyma. Calices with a disk, tentacles, and interseptal mesenteries.

There are three families of the Madreporaria Perforata:—

I. The Eupsammidæ (subfam. Ed. & H.).
II. The Madreporidæ, Ed. & H. (pars).
III. The Poritidæ, Ed. & H.

Forty-two genera and five subgenera are included in these families. Twelve genera have been eliminated, but five become subgenera.

I. Family EUPSAMMIDÆ.

This family includes the very important and now very large group which was considered to be only worthy of the position of a subfamily by Milne-Edwards and Jules Haime (Eupsamminæ, Hist. Nat. des Corall. vol. iii. p. 90, 1860).

The genera included have a very characteristic facies; and although their structures, both hard and soft, ally them most definitely with the Madreporaria Perforata, they are not without some affinities with the Fungida. The soft parts differ from the corresponding structures of the Fungida.

This distinction of the soft parts is important, for some of the species of Eupsammidæ have hard structures, which act as synapticula, and resemble, to a certain extent, the corresponding structures of some of the Plesiofungidæ. Notably this is the case in *Eupsammia* and *Stephanophyllia*. Moseley's researches indicate that this last very fungoid-looking genus is clearly not one of the Fungida, for the soft parts differ (Report on Corals, H.M.S. 'Challenger,' p. 203).

Family EUPSAMMIDÆ.

Syn. *Eupsamminæ*, Ed. & H.

Perforate Madreporaria, simple or in colonies. The corallite walls usually have costæ formed of sclerenchymatous nodules

joined by vertical and transverse processes, and having apertures in the intercostal spaces. Calices well developed. Septa in several cycles, some orders uniting with others, directly or by trabeculæ, to form symmetrical star-like patterns. Septal laminæ stout, and the principal ones entire and imperforate, except sometimes near the wall; the higher orders more trabeculate and perforate. Endotheca scanty. Sclerenchyma may exist. Epitheca occasional. Increase by gemmation and fissiparity.

Although there is a great family likeness amongst the genera now recorded, it is very difficult or impossible to place them all in definite Alliances. Some groups of single genera are therefore established.

But the Eupsammidæ indicate their right to be considered a family by having varieties of form which are noticed in other great families. There are simple and colonial types, and the forms are turbinate, discoid, incrusting and massive, dendroid, &c.; and there are types which undergo fissiparity, gemmation from the sides, and also from stolons.

There are the following Alliances in this family:—Stephanophyllioida, Balanophyllioida, Dendrophyllioida, Leptopsammioida.

I. Alliance STEPHANOPHYLLIOIDA.

Simple Eupsammidæ, with a discoid, basal, horizontal wall.

Genus STEPHANOPHYLLIA, Michelin.
  Subgenus DISCOPSAMMIA, d'Orb.
Genus LEPTOPENUS, Moseley.
Genus CYCLOBACIA, Bölsche.

Discopsammia, d'Orb., becomes a subgenus.

Genus STEPHANOPHYLLIA, *Michelin*, *Article Astrée*, *Dict. des Sci. Nat.*, *Supp.* t. i. p. 484 (1841); *Icones Zooph.* p. 32, pl. 8; *Moseley*, '*Challenger*' *Report on Corals*, p. 198 *et seq.* (1881).

The corallum is simple, free, discoid, with a horizontal wall. Calice circular, with five cycles of septa, and some of a sixth, not projecting outwards, but large, high, thin, and close, uniting by their upper or internal borders, the primaries only being free, with conical projecting points on their sides. Septal edges dentate more or less near the axial space, and the laminæ are of fused trabeculæ more or less perforate. Columella distinct, in a well-marked calicular fossa. Costæ straight, delicate, and radi-

ating regularly from the centre of the base to the circumference, and formed of granules moderately distinct. Wall regularly perforate.

Distribution.—Fossil. Cretaceous, Eocene, Miocene, Pliocene: Europe and England. Tertiary: Asia.—*Recent.* Pacific, Philippines, and Ké Islands.

Subgenus DISCOPSAMMIA, *d'Orbigny, Note sur les Polyp. foss.* p. 10 (1849).

Corallum plano-convex, with a superficial calicular fossette, a rudimentary columella, and the free edges of the septa rounded and slightly denticulate.

Distribution.—Fossil. Cretaceous series of Europe.

This subgenus corresponds to the Lenticular *Stephanophylliæ* of Milne-Edwards and Jules Haime.

Genus LEPTOPENUS, *Moseley, Report on 'Challenger' Corals,* 1879 (pub. 1881), p. 204.

Corallum discoid, excessively thin and fragile, with the wall so completely covered by perforations as to resemble lacework, being built up of a network of delicate radiating and circumferentially-directed trabeculæ. Perforations placed at regular intervals between the costæ, and each divided into two by the septa, which alternate with the costæ. Septa, except the primaries, which are free, coalescing successively according to order, and forming deltoid figures beset with a series of long, outwardly-directed spines on their free margins; attached beneath to the transverse trabeculæ, which separate from one another the perforations of the wall by a series of short processes, in the intervals between which their lower margin is free. Columella large, spinous. Tentacles knob-bearing.

Distribution.—Recent. Sea-floor of Southern Hemisphere, deep water (over 1500 fms.), South Atlantic, South Indian Ocean, and off Valparaiso.

Genus CYCLOBACIA, *Bölsche, Zeitschr. deutsch. Geol. Gesell.* Band xviii. p. 473 (1866).

This is probably identical with *Fungia*, and is therefore a link between *Micrabacia* and *Fungia*. I do not place the genus.

Distribution.—Fossil. Cretaceous: Europe.

II. Alliance BALANOPHYLLIOIDA.

Eupsammidæ with simple coralla, rarely budding, well-developed calices. Columella variable; and fully-developed septal orders. Costæ variable.

Genus BALANOPHYLLIA, S. Wood.
Subgenus THECOPSAMMIA, Pourtalès.
Genus EUPSAMMIA, Ed. & H.
Genus ENDOPACHYS, Lonsdale.
Genus HETEROPSAMMIA, Ed. & H.

Thecopsammia, Pourtalès, becomes a subgenus.

Genus BALANOPHYLLIA, *Searles Wood, Ann. & Mag. Nat. Hist.* vol. xiii. p. 11 (1844), *amended.*

Corallum simple, or budding around the base, but never forming true colonies or dendroid masses; fixed by a broad or narrow base, or pedicellate and becoming free, very variable in shape, and may be turbinate, straight, or curved, subturbinate, conico-cylindrical, and curved. Calice elliptical, rarely circular, sometimes deformed. Columella not projecting at the bottom of the calice, variably developed—long, narrow, wide or large, and finely spongy. Septa thin, close, numerous, perforate near the wall, the highest cycle curving towards the penultimate, and larger than these; granular at the sides, and joining by the granules. Wall porous, variably stout. Costæ well developed, distinct, subequal. Epitheca present or absent.

Distribution.—Fossil. Eocene: England and Europe. Miocene: Europe. Pliocene: England and Europe.—*Recent.* Mediterranean, English Channel (*B. regia*), St. Helena, Madeira, Philippines, Fiji, Japan, Corea, Chinese seas, Australian seas, California, Caribbean Sea.

Subgenus THECOPSAMMIA, (genus) *Pourtalès, Deep-Sea Corals,* p. 43 (1871).

Corallum simple, attached, pedunculate, turbinate, or subcylindrical. Wall thick, very porous and vermiculated. Calice slightly elliptical, deep. Septa well developed, not exsert, granular; those of the 4th and 5th orders bend towards the tertiaries or unite in front of them. Columella papillose, porous or sublamellar and compact, and forming three masses. Costæ

obscure. Epitheca well developed, coming up not far from the calicular edge, marked with ridges or not, and its substance penetrating the porose wall.

Distribution.—Fossil. Pliocene: England (specimen in York Museum).—*Recent.* Philippines, Admiralty Islands, Florida, North Atlantic. Deep water.

Genus EUPSAMMIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 94 (1860).

Corallum simple, subturbinate, free in adult age, when the traces of adherence gradually disappear, compressed or not. Calice elliptical or suboval, deep and narrow centrally. Columella variably developed, of twisted processes, tubercular or papillary, or spongy, or barely existing. Septa solid or roughly perforated, numerous, close, well developed, slightly exsert, strongly granular on their sides, and uniting by the granules here and there; the septa of the last cycle more developed than the penultimate, and curving towards and joining or not the septa of the cycle preceding them in age. Wall porous, naked, showing simple, close, unequal verrucellate, distinctly granular costæ.

Distribution.—Fossil. Eocene, Oligocene, Miocene: Europe.—*Recent.* Chinese seas.

Synapticula are often seen near the calicular margin, between septa.

Genus ENDOPACHYS, *Lonsdale, Quart. Journ. Geol. Soc. Lond.* vol. i. p. 214 (1845).

Corallum simple, straight, free, compressed and keeled along the narrow base and sides, where there are also costal wing-shaped appendices. Calice with unequal axes on different planes; the fossette long and narrow. Columella spongy, slightly developed. Septa in five cycles, narrow, slightly exsert, close, the higher cycle joining the preceding, sides granular.

Distribution.—Fossil. Eocene: Alabama.—*Recent.* Australian seas?

Genus HETEROPSAMMIA, *Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3e sér. t. x. p. 89 (1848); *Hist. Nat. des Corall.* vol. iii. p. 105.

Corallum simple, straight, low, increasing fissiparously so as

to form a compound corallum with two or more calices. The base broad, flat, unsymmetrical, tumid, containing a Sipunculid worm, and perforated for it. Calice circular, close, or a figure of 8, or round, open, shallow. Columella spongy, well developed, deep. Septa numerous, many joining near the columella. Wall stout, porous, often enlarged at certain spots around the calice. Costæ not present, but replaced by series of very small granules, coalescing into papillæ or small striæ.

Distribution.—Recent. Chinese seas, Burmese seas, North-Australian seas, Philippines, E. Africa and islands.

The porosity of the wall, the relations of the septa, and the absence of pali separate the genus decidedly from *Stephanoseris*.

III. Alliance DENDROPHYLLIOIDA.

Colonial Eupsammidæ, with well-developed calices and septa. Columella variable in development, spongy, lamellar, or absent. Cœnenchyma variable. Dissepiments rare.

Genus DENDROPHYLLIA, Ed. & H.
  Subgenus CŒNOPSAMMIA, Ed. & H.
Genus PLACOPSAMMIA, Reuss.
Genus ASTROPSAMMIA, Verrill.
Genus PACHYPSAMMIA, Verrill.
Genus STEREOPSAMMIA, Ed. & H.
Genus CALOSTYLIS, Lindström.

Genus absorbed:—
  BRASSYIA, B. Wright.

CŒNOPSAMMIA, Ed. & H., becomes a subgenus. AULOPSAMMIA, Reuss, is not a Madreporarian.

Genus DENDROPHYLLIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 112 (1860).

Syn. *Brassyia*, B. Wright.

Colony generally dendroid and high or low, corymbose or cæspitose, or forming clumps; increasing by gemmation, which is lateral or subbasal. Corallites rather large, cylindrical, cylindro-turbinate, more or less elongate. Calice subcircular, deep. Columella more or less developed, often large. Septa barely exsert or not, thin, close, those of the fourth cycle well developed, and the septa of the last cycle or cycles bending to their predecessors and uniting or not to them. Walls subcostate near the calices, covered with rough vermiculate grains in rows, with irregular spaces between.

Milne-Edwards and Jules Haime divide this genus into groups of species :—

1. Arborescent *Dendrophylliæ*. With an arborescent trunk, branches arising from it in vertical series, and ramifying in their turn in an alternate and distichous manner.
2. Branching *Dendrophylliæ*. The parent occupies the axis of the corallum or colony, and the secondary branches arise around it, forming several vertical series, some uniting when they come in contact.
3. Incrusting *Dendrophylliæ*. Not developing much in height by budding, and resembling an Astræiform mass, with some cœnenchyma. Corallites often uniting about the base.

Distribution.—Fossil. Eocene: England and Europe. Miocene: Europe.—*Recent.* Atlantic, Cape Verd, Madeira, Mediterranean, Pacific, Arafura Sea, Chinese and Australian seas, Bay of Panama, Caribbean Sea.

The genus *Brassyia*, B. Wright, Ann. & Mag. Nat. Hist. 1862, ix. p. 77, was established for specimens of one species. It is a stumpy, broad-based coral, clearly colonial, from the buds upon it, although it is stated to be simple. The only interesting point is that the septa are said not to unite.

It is synonymous with *Dendrophyllia*, and is in no way intermediate between *Dendrophyllia* and *Balanophyllia*.

Subgenus Cœnopsammia, (genus) *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 125 (1860), *amended.*

Colony in tufts, or fasciculate or dendroid, rarely massive. Corallites more or less cylindrical, free or surrounded by cœnenchyma. Calices subcircular. Columella well developed. Septa not exsert, in three complete cycles, and whenever there are higher orders they are rudimentary. Costæ delicate, subvermiculate inferiorly, simply granular near the calice. Gemmation lateral and subbasal. Septa and wall differing in the amount of perforation.

Distribution. — Fossil. Pliocene: Europe. — *Recent.* Indian Ocean, Red Sea, Pacific, North-Australian seas, New Zealand, Panama, Cape Verd Islands.

Genus PLACOPSAMMIA, *Reuss, Sitzungsb. der Kais. Akad. der Wiss. Wien*, Bd. xxxv. p. 486, pl. 2. fig. 16 (1859); *Duncan, "Deep-Sea and Littoral Corals," Proc. Zool. Soc.* 1876, p. 441.

Colony with a broad base, and short stunted projections, ending in elliptical calices. Columella long and lamellary, compact. Septa in four cycles, and with some of the orders uniting, as is usual in the Eupsammidæ. Costæ visible to the base, often wavy and inosculating.

Distribution.—Fossil. Miocene, Oligocene: Europe.—*Recent.* Galapagos?

Genus ASTROPSAMMIA, *Verrill, Notes on Radiata*, p. 509 (1868–70).

Colony massive. Corallites united to their summits by an abundant, very porous cœnenchyma. Walls scarcely distinct from the cœnenchyma, very porous. Septa in four cycles, with some orders of the fifth; those of the fourth unite to the tertiaries. Columella usually well developed, composed of loose, convoluted, and twisted lamellæ and trabeculæ. Interseptal spaces cut off below by thin transverse dissepiments, which often coincide in all the chambers. Calices shallow. Gemmation chiefly marginal and interstitial. Fissiparity may occur.

Distribution.—Recent. Mergui, Burmah; Gulf of California.

Some forms considered to be *Cœnopsammiæ*, and which have cœnenchyma, belong to the next genus.

Genus PACHYPSAMMIA, *Verrill, Proc. Essex Institute*, vol. v. (1866–67).

Colony massive and incrusting. Corallites united near their summits by a massive cœnenchyma. Four complete cycles of septa. Columella rudimentary or trabecular, not salient. Surface of the cœnenchyma with waving ribs. Gemmation lateral, irregular.

Distribution.—Recent. Chinese seas.

This genus approaches *Stereopsammia*, but has a solid cœnenchyma. It differs from *Dendrophyllia* in not having a distinct columella.

Genus STEREOPSAMMIA, *Milne-Edwards & Jules Haime, Brit. Foss. Corals, Introd. Pal. Soc.* p. 43 (1850).

Colony incrusting, glomerulate. Corallites short, united at the base, free near the calice. Calices circular, rather deep.

Columella absent or rudimentary. Septa hardly exsert, those of the last cycle less developed than those of the penultimate. Costæ fine, close, frequently discontinuous and vermiculate. Gemmation irregular, and from the base.

Distribution.—Fossil. Eocene: England.

Pourtalès considered his *Amphelia rostrata* to belong to this genus; but it can hardly be included.

Lindström has described, with his usual care, a remarkable coral, which he considers to be one of the Eupsammidæ, from the Silurian strata of Gothland. The description and figures carry conviction that this genus, *Calostylis*, is one of the Perforata, and that it should be placed in the Eupsammidæ. The resemblance of the thick mural structure of the calices to that of *Thecopsammia*, Pourtalès, is very striking.

Genus Calostylis, *Lindström, Œfversigt af K. Vetensk.-Akad. Förhandl.* p. 421 (1868).

Colony cylindro-conical, uniserial, budding between the calice and the base. Septa numerous, thin, coalescing, irregularly perforated, ragged at the upper free edge, and forming a trabeculate columella with their inner ends. Columella broad, convex. Dissepiments few. Costæ extend from the calice to the base, and are covered here and there by a smooth thin epitheca.

Distribution.—Fossil. Silurian: Gothland.

The above diagnosis is compiled from Lindström's generic diagnosis, and from the description of the species, *Calostylis cribraria*. Lindström's diagnosis is rather too short for the purposes of comparison with other Eupsammidæ:—"Polyparium compositum, gemmatio uniserialis, lateralis, septa numerosissima, interdum inter se coalescentia, columella trabecularis, epitheca incompleta."

IV. Alliance LEPTOPSAMMIOIDA.

Simple Eupsammidæ with irregular septal development.

Genus Leptopsammia, Ed. & H.
Genus Endopsammia, Ed. & H.

There are two genera, each established for one species only, which are exceedingly unsatisfactory. They are *Leptopsammia* and *Endopsammia* of Milne-Edwards and Jules Haime. They are closely allied, and in both there is an imperfection of the

fourth cycle, and a deficiency of that lateral junction of the septa which is so generally characteristic of the family.

Genus LEPTOPSAMMIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 106 (1860).

Corallum simple, adherent, tall, subturbinate, narrow at the base. Calice elliptical, with a large and deep fossa. Columella very developed, projecting. Septa not exsert, moderately close, very thin, barely granulated; the septa of the first and second cycles nearly equal, the septa of the fourth order curved towards the tertiaries, which they reach at a little distance from the columella. The septa of the fifth order perforate, denticulate, projecting barely from the wall. Epitheca rudimentary near the base. Costæ distinct.

Distribution.—Recent. Philippines.

Genus ENDOPSAMMIA, *Milne-Edwards & Jules Haime, Ann. des Sci. Nat.* 3ᵉ sér. t. x. p. 92, pl. 1 (1848).

Corallum short, straight, adherent by a broad base. Calice circular, with a deep fossa. Columella spongy, well developed and projecting. Septa stout, exsert, very largely granular. The fifth order rudimentary, the fourth curving towards the tertiaries; these and the primaries large and nearly equal. Costæ well developed. Wall thick and porous. A pellicular epitheca.

Distribution.—Recent. Philippines.

The following genera cannot be placed in Alliances:—

Group. Incrusting colonial Eupsammidæ.
Genus ASTROIDES, Blainville.

Group. Fissiparous colonial Eupsammidæ.
Genus LOBOPSAMMIA, Ed. & H.

Group. Simple Eupsammidæ, budding from the wall.
Genus RHODOPSAMMIA, Semper.

Group. Colonial Eupsammidæ, budding from stolons.
Genus RHIZOPSAMMIA, Verrill.

Genus ASTROIDES, *Blainville, Dict. des Sci. Nat.* t. lx. p. 332, *in Hist. Nat. des Corall.* vol. iii. p. 131 (1860).

Colony incrusting, massive. Corallites imperfectly united, or free at their sides. Wall spongy, but dense. Calices circular or polygonal, free or united by their edges. Columella very deve-

loped, projecting, spongy. Septa moderately developed, very thin, not exsert, finely and unequally dentate, those of the last cycle less developed than those of the penultimate. Endotheca scarce. Epitheca surrounding the corallites thin and compact.

Distribution.—Recent. Mediterranean.

Genus LOBOPSAMMIA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 123 (1860).

Colony dendroid and very short and dichotomous, short branches directed outwards. Calices with irregular-shaped margins, increasing by fissiparity. Four cycles of septa well developed, and some of the fifth; higher orders bending to and joining the penultimates. Columella spongy. Costæ delicate, with indistinct granules.

Distribution.—Fossil. Oligocene: Europe.

Genus RHODOPSAMMIA, *Semper*, "*Generationswechsel bei Steinkorallen*," *Zeitschr. für wiss. Zool., Leipzig*, vol. xxii. p. 257 (1872).

Corallum simple or colonial, free or attached, with lateral buds, cylindro-conical or compressed. Calice elliptical, rather deep. Columella more or less projecting, composed of convoluted "leaflets." Septa narrow, sharp at the edge, hardly exsert; first and second cycles extending to the columella, unequal; succeeding cycles joined with those of preceding cycle. Costæ simple, distinct from the base, close, subequal, granular. Epitheca absent or rudimentary.

Distribution.—Recent. Philippines.

Several species of this interesting genus are described by Semper and beautifully figured. The budding is below the calicular margin, and some buds may bud again. The parent is clearly alive after this process, and the whole colony is a pale pink in colour when alive, and the tentacles, which are long, are of a deeper tint. Some coralla are attached, others are free; and some have buds, others have not. In one instance there is a bud with a quadrangular transverse outline springing from the calicular margin.

Genus RHIZOPSAMMIA, *Verrill, Notes on Radiata*, p. 510 (1868–70).

Colony low, incrusting, extending by stolon-like expansions of

the base, from which buds arise. Corallites cylindrical or nearly so, connected by thin creeping expansions, which have the same texture as the wall. Calices subcircular or elliptical. Septa thin, crowded, a little projecting, arranged in four or five cyles; last cycle well developed, uniting to those of the preceding cycle, which rise up in the form of prominent paliform lobes, beyond which the central region of the calice is deep. Columella very porous and its surface papillose. Wall very porous. No epitheca. Costæ scarcely distinct, represented by series of rough granules.

Distribution.—Recent. Pacific, Pearl Islands.

II. Family MADREPORIDÆ (*pars*), *Ed. & H.*

This family corresponds to the subfamily Madreporinæ, Ed. & H. It is necessary to give the subfamily the position of a family, not only because the Eupsammidæ have become a family, but also because it is evident that the great genus *Madrepora* will eventually be largely subdivided. The subfamily Turbinarinæ, Ed. & H., is included in this family.

Colonial perforate Madreporaria, increasing by gemmation; cœnenchyma more or less abundant, spongy, and reticulate, slightly or not distinct from the porous corallite-walls. Septa lamellar, slightly porous, or else solid, variable in number and size. Calices prominent or sunken.

Alliances:—Madreporoida, Turbinaroida. These alliances were subfamilies according to Milne-Edwards and Jules Haime.

I. Alliance MADREPOROIDA.

Madreporidæ with diverse shapes, usually ramose or foliaceous or incrusting. Cœnenchyma moderate or considerable. Septa with two opposite primaries larger than others. Interseptal loculi with dissepiments. Gemmation symmetrical or not, extracalicular. Calices more or less prominent and variable in shape.

Genus MADREPORA, Linnæus.
Subgenus ISOPORA, Studer.

Genus MADREPORA, *Linnæus, Syst. Nat.* edit. x. p. 793, *amended.*

Colony very variable in shape, branching, bush-shaped,

expanding, flat, corymbiform, or foliaceous, pedunculate or incrusting. Gemmation around the parent corallite and from the side of other calices. Cœnenchyma abundant, spongy, reticulate, spinulose, growing exogenously from the porous walls of the corallites. Calices variable in shape, projecting or immersed, but never all so; terminal calices, or some amongst the mass, longest or largest (parents). Septa distinct, variable in solidity, two opposite primaries largest and nearly meeting. Twelve tentacles, and one larger than the others. No columella. An endotheca may exist, which occasionally becomes tabulate.

Distribution.—Fossil. Eocene: Europe, India. Oligocene: England and Europe. Miocene: Europe; Sind, Asia.—*Recent.* Red Sea, Indian Ocean, Oceania, Pacific, Caribbean Sea.

Subgenus Isopora, *Studer*, *Monatsbericht der König. Preuss. Akad. der Wiss. Berlin*, 1878, p. 535 (*Gazelle Corals*).

Colony leaf-shaped or lobate. Calices equally prominent, and distributed over the whole surface. The apical calices are wanting.

Distribution.—Recent. Philippines.

II. Alliance TURBINARIOIDA.

Madreporidæ in colonies, with an abundant cœnenchyma between the corallites, which is distinct from the mural structures, spongy and reticulate. Increase by gemmation.

Genus Turbinaria, Oken.
Genus Astræopora, Blainville.
Genus Dendracis, Ed. & H.
Genus Actinacis, d'Orbigny.
Genus Palæacis, Haime.
Genus Prisciturben, Kunth.
Genus Stylaræa, Seebach.

Genus Turbinaria, *Oken*, 1815; *Milne-Edwards & Jules Haime*, *Polyp. des terr. Paléoz.* p. 141.

The colony is usually crateriform or foliaceous and twisted. There is an abundant cœnenchyma between the corallites, and it is dense and also echinulate at the surface. The calices are more or less projecting. The septa are nearly all of the same size; and there is a well-developed spongy columella.

Distribution.—Fossil. Miocene of France, Sind, Asia.—*Recent.* Red Sea, Indian Ocean, Pacific.

This genus was shown by Milne-Edwards and Jules Haime to absorb *Gemmipora*, Blainville, and *Explanaria* (pars), Lamarck.

Genus Astræopora, *Blainville*, *Dict. des Sci. Nat.* t. ix. p. 348 (1830).

The colony is massive in shape, adherent or incrusting. The cœnenchyma is lax, and decidedly echinulate at the surface. The septa are unequally developed on the small calices. There is no columella. Tabulæ are seen in some specimens.

Distribution.—Fossil. Eocene of Europe and West Indies. Miocene: Sind, Asia.—*Recent.* Red Sea, Indian and Pacific Oceans.

Genus Dendracis, *Milne-Edwards & Jules Haime*, *Hist. Nat. des Corall.* vol. iii. p. 169 (1860).

The colony is arborescent, and the cœnenchyma is very dense and granulated at the surface. Calices submammiform. Septa few in number, subequal. No columella.

Distribution.—Fossil. Eocene of Europe.

Genus Actinacis, *d'Orbigny*, *Note sur les Polyp. foss.* p. 11 (1849).

Colony subdendroid, with a greatly developed cœnenchyma, which is rather dense and granulated, and not very perforated. Calices circular, small, distant. Septa few in number, subequal, somewhat exsert. A columella, which is papillose. Pali exist before all the septa.

Distribution.—Fossil. Cretaceous of Europe.

Genus Palæacis, *J. Haime*, 1860. (Amended by Seebach, Zeits. der Deutsch. Geol. Gesellsch. Bd. xviii. p. 308, Berlin, 1866.)

Syn. *Sphenopoterium*, Meek and Worthen.

Colony pedunculate, cuneiform. Calices immersed in a vermiculate perforate cœnenchyma, marked with anastomosing striations. Calice-walls of the same structure as the cœnenchyma, thick, but porous. Calicular margins circular in outline. Calices widely open. Septal system of fine, numerous, unequal striations (30). Gemmation intercalicular, and producing occasionally by pressure polygonal calicular margins.

Distribution.—Fossil. Carboniferous: America.

Genus PRISCITURBEN, *Kunth, Zeits. der Deutsch. Geol. Gesellsch.* Bd. xxii. p. 25 (Berlin, 1870).

Colony low, expanding, attached by the whole base. Cœnenchyma well developed, compact, and composed of a sponge-like structure. Calices projecting, rather inclined, differing in size, nearly or quite circular in outline, surrounded by cœnenchyma. Septa variable, both thick and thin. Columella spongy.

Distribution.—Fossil. Silurian: Oeland.

This is a very puzzling genus, and its characters have been very ably described and delineated by Kunth. Its position is probably amongst the Turbinarinæ.

Genus STYLARÆA, *Seebach, Zeits. der Deutsch. Geol. Gesellsch.* Bd. xviii. p. 306 (Berlin, 1866).

Colony low, covering some space, with a crust-like, vermiculate, perforated cœnenchyma and a basal epitheca. Calices polygonal, moderately deep, with a stout, projecting, spongy columella. Septa strongly crenulate, in two cycles. Walls moderately stout, bearing points in the angles of the calices.

Distribution.—Fossil. Lower Silurian: Europe (Wesenberg).

III. Family PORITIDÆ, *Ed. & H.*

Perforate Madreporaria composed of reticulate and trabeculate sclerenchyma. Septa never completely lamellary, but trabecular and fenestrated, or as series of discontinuous trabeculæ. Walls very porose. Corallites increasing by gemmation, and united directly or by intervening porous sclerenchyma. Dissepiments and tabulæ may exist.

There are two Alliances—the Poritinoida and the Montiporoida.

I. Alliance PORITINOIDA.

Corallites united by their trabeculate walls without intervening cœnenchyma, or with some of very rudimentary kind.

Genus PORITES, Ed. & H.
Genus SYNARÆA, Verrill.
Genus NAPOPORA, Quelch.
Genus DICTYARÆA, Reuss.
Genus RHODARÆA, Ed. & H.
Genus GONIOPORA, Quoy et Gaimard.
Genus LITHARÆA, Ed. & H.

Genus PROTARÆA, Ed. & H.
Genus ALVEOPORA, Quoy et Gaimard.
Subgenus FAVOSITIPORA, S. Kent.
Genus SOMPHOPHORA, Lindström.
Genus DICHORÆA, T. Woods.

Genera absorbed:—STYLARÆA, Ed. & H., non Seebach; MEANDRARÆA, Etallon.

FAVOSITIPORA, S. Kent, becomes a subgenus; KONINCKIA, Ed. & H., a doubtful genus.

Genera removed:—MICROSOLENA, Lamour.; COSCINARÆA, Ed. & H.; DICTYOPHYLLIA, Blainville; PLEURODICTYUM, Goldfuss; HOLARÆA, Ed. & H.; CŒNOSTROMA, Winchell.

Genus PORITES, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 173, *altered.*

Colony ramifying, or in tufts, or foliaceous, often massive, and lobed or low, incrusting or not. A basal epitheca invariable in the last instance, frequent in all. Corallites with trabeculate and perforate walls, not distinct from those of their neighbours, and therefore without intermediate cœnenchyma. Calices small, pentagonal. Septa twelve or less, feebly developed, trabecular or spinulose. A small columella, forming at its free end a knob or a trabecular point or a style. Pali five or six, and not very distinct from the septal ends, in a circle around the columella. Endotheca exists sparingly, and may be dissepimental or tabulate, or may be mere stereoplasm.

Distribution.—Fossil. Eocene: Europe, Sind, Asia. Miocene: West Indies and Europe, Sind, Asia.—*Recent.* Red Sea, Indian Ocean, Pacific, West Indies.

This genus absorbs *Stylaræa*, Ed. & H., 1851.

The absence of any intercorallite reticular tissue or cœnenchyma is invariable in the recent forms; but in the Eocene *Porites panicea*, Lonsdale, there is a small quantity in some parts of a colony, but not in all (Supp. Brit. Foss. Corals, Pal. Soc. 1866, p. 63; P. M. Duncan).

Genus SYNARÆA, *Verrill, Bull. Mus. Comp. Zool. Cambridge, Mass.* 1864, No. 3, p. 42.

Corallum irregularly branched or glomerate. Corallites without distinct walls. The septa rudimentary. Six prominent and paliform lobes surround the central cavity, which has a small rudimentary tubercular columella. Outside of the pali are other

similar points or granulations scattered between the cells (corallites), which are not distinctly circumscribed, but often separated for some distance by a porous cœnenchyma.

Synaræa includes *Porites conformis*, *P. monticulosa* of Dana; also *Porites antiqua*, Dana, = *P. Danæ*, Ed. & H.

Distribution.—Recent. Pacific.

Genus NAPOPORA, *Quelch, Ann. & Mag. Nat. Hist.* 1884, xiii. p. 296.

Corallum compound, porous. Gemmation intracalicinal, the developing buds with distinct centres almost destitute of distinct walls, at first united in groups of 2–6, and surrounded by the common wall of the parent calicle; but as development proceeds they are separated off by a narrow, raised, distinct wall. Calicinal depressions very variable in size and shape, according to the number, position, and degree of development of the buds. Walls of the older calicles porous, distinctly raised, and angular. Septa generally of two cycles, rudimentary. Pali six, sometimes one smaller than the others or absent, generally well developed, and distinctly marking the position of the calicinal centres. Columella rudimentary, represented by small papilliform projections, often absent.

Distribution.—Recent. Tahiti.

Genus DICTYARÆA, *Reuss, Foss. Korallen aus der Insel Java, Novara Exped., Geolog. Theil*, p. 175, pl. ii. fig. 6.

The colony is in knotty branchlets. The calices are rather irregular in shape, generally pentagonal, separated by a slight ridge. Septa few, about 6 to 12, uniting around the axis by false paliform lobes. Columella absent. Considerable distinction between the size of the calices and the dimension of the septa.

Distribution.—Fossil. Eocene: Java, Asia, Europe.

Genus RHODARÆA, *Milne-Edwards & Jules Haime, Compt. Rend.* t. xxix. p. 259 (1849).

The colony is massive; the calices are deep and pentagonal; the trabeculæ of the walls of the corallites are well developed, but they retain their spongy appearance. Septa trabecular, not much developed, and in three cycles. Columella absent or rudimentary. Pali six in number and very large, placed before the secondary septa.

Distribution.—Fossil. Miocene of West Indies and France.—*Recent.* Australian and Chinese seas, Indian Ocean.

Genus GONIOPORA, *Quoy & Gaimard, Voy. de l'Astrolabe, Zooph.* p. 218 (1833).

Colony attached or free, lobed or hemispherical, or in tall blunt cylindrical masses. Corallites with distinct trabecular walls joining those of their neighbours, without intermediate tissue. Calices unequal in size, and shallow or deep, pentagonal. Septa projecting but little in the upper part of the calices and ragged, extending towards the columella as porose trabecular laminæ. Columella well developed, spongy. No pali. Gemmation between the calices. Endotheca exists.

Distribution.—Recent. Red Sea, Indian Ocean, Pacific.

Genus LITHARÆA, *Milne-Edwards & Jules Haime, Comptes Rendus*, t. xxix. p. 258 (1848), *amended.*

Colony low, free or incrusting, lobed, or dendroid, or discoid, with an imperfect or well-developed epitheca. Corallites with trabecular porose walls adherent to, or fused with those of their neighbours. Calices polygonal or irregular. Septa well developed, and subperforate and echinulate. Columella trabecular, and formed by the septal ends. No pali.

Distribution.—Fossil. Cretaceous (Upper): Europe. Eocene: Europe, Sind, Java. Oligocene: Europe. Miocene: France.

The septa approach those of the Astræidæ, and the genus is closely allied to the recent *Goniopora.*

Some comparatively late researches on the next genus have modified the generic diagnosis, and have given a higher distributional range to the species.

Genus PROTARÆA, *Milne-Edwards & Jules Haime, Hist. Nat. des Corall.* vol. iii. p. 184 (1860), *amended.*

Colony incrusting and massive. Corallites polygonal, with simple perforated walls, which at the calicular surface are narrower than the calice by one half, and are ornamented with points. Calices shallow. Septa 6–12 to 24 in number, pass a little way in and are sublamellary and dentated. No columella.

Distribution.—Fossil. Silurian: America. Devonian: Europe.

Genus ALVEOPORA, *Quoy & Gaimard, Voy. de l'Astrolabe, Zooph.* p. 394 (1834).

Colony lobed, convex, foliaceous or dendroid. Corallites united by very largely fenestrated trabecular walls. Calices polygonal, deep, usually unequal. Septa as simple series of distant spiniform trabeculæ, which may ramify near the axial space, and form a false columella or not. Epitheca basal or pellicular.

Distribution.—Fossil. Oligocene: Java. Miocene: West Indies, Europe.—*Recent.* Red Sea, Pacific, Indian Ocean.

In some specimens of *Alveopora viridis*, Quoy (*A. spongiosa*, Dana), there are tabulæ; but there are twelve tentacles, which are short and cylindrical. They have been placed in the following subgenus.

Subgenus FAVOSITIPORA, *Saville Kent, Ann. & Mag. Nat. Hist.* ser. 4, vol. vi. (1870), p. 386, pls. 17, 18.

The corallum resembles that of *Alveopora*, and has tabulæ.

Distribution.—Fossil. Palæozoic: America.—*Recent.* Locality unknown.

This type belongs to the *Alveopora-viridis* group, and can hardly be separated from *Alveopora* generically. It had better include the tabulate *Alveoporæ* for the future, which are nevertheless true Perforata.

The genus *Koninckia*, Ed. & H. Hist. Nat. des Corall. vol. iii. p. 263, is one of the *Alveopora-Favositipora* group, and is ill-defined. It is from the White Chalk of Royan.

Genus SOMPHOPHORA, *Lindström, Richthofen's China*, vol. iv. p. 51 (1883).

Colony with deep polygonal calices. Wall thick, indistinctly fenestrate with large spaces. Six septa, rather distant, having pointed dentations, not uniting together nor reaching the centre of the calice. Dissepiments (tabulate) irregularly distant one from another.

Distribution.—Fossil. Silurian: China.

Lindström, with his usual perspicuity, places this genus in the neighbourhood of *Alveopora* and *Favositipora*.

Genus DICHORÆA, *T. Woods, Proc. Linn. Soc. New South Wales*, vol. iii. (1879), p. 96.

Colony turbinate, pedunculate, broadly attached. Calices

polygonal, numerous, minute, irregular. Septa a series of needle-shaped points. Wall of corallites thickly studded with short, stout, and very conical points, swollen at the base, and pointing towards the interior of the fossa. A common epitheca in very thick folds. Gemmation intracalicular.

Distribution.—Recent. Pacific.

The Rev. T. Woods gives a delineation of the species; and there is no intermediate cœnenchyma shown between the calices.

M. de Fromentel, *op. cit.* p. 256, places the genus *Pleurodictyum*, Goldfuss, in the group Perforata, which includes *Porites*. This genus finds no place amongst the Madreporaria Perforata, as it is founded on a cast of a species of the genus *Michelinia*, a Palæozoic tabulate form which in all probability belonged to the Alcyonaria.

M. de Fromentel* places the genus *Holaræa*, which was founded by Milne-Edwards and Jules Haime to receive *Alveolites parisiensis*, Michelin, amongst the Perforata in the neighbourhood of *Porites*. The condition of the specimens on which the above-named species was established is very defective. Milne-Edwards and Jules Haime, in 1860, in their 'Hist. Nat. des Corall.' vol. iii. p. 244, place *Holaræa* as a synonym of *Axopora*, a genus with tabulæ, and certainly not one of the Madreporaria, but an Alcyonarian. *Holaræa* is therefore no longer a genus.

The genus *Cœnostroma*, Winchell, is probably an ally of *Stromatopora*, and not a coral.

II. Alliance MONTIPOROIDA.

Poritidæ with a more or less abundant spongy cœnenchyma.

Genus Montipora, Quoy & Gaim.
Genus Anacropora, Ridley.

Genus Montipora, *Quoy et Gaimard, Voy. 'Astrolabe,' Zooph.* p. 247 (1833); *Verrill, Notes on Radiata, Revision of Corals of West Coast of America* (1868–70), p. 502.

Colony various in form, glomerate, massive, incrusting, foliaceous, lobate or branching. Cœnenchyma abundant, porous, or spongy, usually echinulate at the surface, and often rising into ridges, papilliform eminences, and crests between the corallites;

* 'Introd. à l'Etude des Polyp. foss.,' Paris, 1858–60.

usually very different on the base. Corallites small, wide apart, separated by cœnenchyma in which they are immersed, or else the calicular margin is raised, lacerate, and spinulose. Calices deep, with columella and pali. Septa little developed, six or twelve, and often trabecular. Secondaries smaller than the primaries.

Distribution.—Recent. Red Sea, Indian Ocean, Pacific.

Mr. S. O. Ridley has investigated and described a very interesting form, which he places in a new genus, *Anacropora*. The aspect of the species is that of one of the Madreporidæ, and the two large primaries add to this character; but the gemmation differs. The septa are trabecular, but are fairly developed.

Genus Anacropora, *Ridley, Ann. & Mag. Nat. Hist.* ser. 5, vol. xiii. p. 287 (1884).

Colony ramose. Axis and apex of branches formed by a spongy cœnenchyma. New calicles formed centripetally, *i. e.* from the base towards the apex; no calicle of any kind at the apex. Calicles equally distributed all round stem and branches, with a tendency to arrangement in longitudinal series. Septa trabeculate, comprising two cycles of six septa each, two (approximately upper and lower) primaries being larger than the four lateral primaries.

Distribution.—Recent. Keeling Islands.

The proper position of *Psammocora* is with the Lophoserinæ, p. 161. I have only been able to study this genus after going to press.

Genus Psammocora, *Dana, Zooph. Wilkes Exped.* (1846), p. 344, *amended.*

Colony in ramose tufts; branchlets often lobed, or in convex masses, or foliated and lobed. Surface more or less irregular, from gibbous humps or linear elevations. Cœnenchyma exists in places, especially on the gibbosities, which, however, just as frequently are covered with calices. Calices small, centres distinct, but margins ill-defined, usually circular, shallow, with a small central fossa with a minute papilla, the top of the columella. Septa 6–9–12 in number, very variable in thickness; sometimes one half of them reach the columellary space, and form a ring of tissue around the columella, the other septa having previously united to them; or several septa are club- or boss-shaped at their free margins, and are much larger than the others which environ them. These larger septa

appear isolated, but are continuous with laminæ that extend downwards. Sometimes these boss- or club-shaped septa are found beyond the calices and between sets of them, and thus resemble the tentacular septa of the family Fungidæ. Here and there great confusion of calices and these septa is apparent. The costæ are indefinite, but they are continuous with the septa, and reach over linear elevations, and sometimes cover much space. They often bifurcate. Septa solid, spinulose, connected by numerous small synapticula. Wall formed by synapticula, which exist between the costæ also. Gemmation and rarely fissiparity.

Distribution.—Recent. Indian Ocean, Chinese seas, Pacific.

Psammocora, Dana, was splendidly illustrated by Dana in his great work, and the remarkable superficial views given, are often strikingly correct. But with age and after death deposit of carbonate of lime occurs, in the first instance consolidating the tissues, and in the other adding to their density. Sections, or rather fractures, made longitudinally and transversely, prove that the septa are solid, stout, spinulose at the free surface, and that synapticula abound. There is some cœnenchyma between corallites here and there, sometimes forming monticules; and it is evident that fissiparity may occur, but it is rare. Under the circumstances the genus must be removed from the section Perforata into that of the Fungida, family Lophoseridæ, near *Plesioseris*, nobis.

The following nine genera are new:—

Antillastræa, p. 108.	Physophyllia, p. 118.
Brachymæandrina, p. 90.	Pourtalosmilia, p. 72.
Diplothecastræa, p. 115.	Pratzia, p. 160.
Koilocœnia, p. 115.	Zittelofungia, p. 150.
Nototrochus, p. 17.	

Total number of genera recorded, after revision, 343 out of 478.

List of Sections and Families of Madreporaria.

List of Genera &c.

I. Section *MADREPORARIA APOROSA.*

II. Family OCULINIDÆ.

Alliance BARYHELIOIDA.

Genus

Baryhelia, *Ed. & H.*, p. 37.
Neohelia, *Moseley*, p. 37.
Diblasus, *Lonsdale*, p. 38.

Alliance LOPHOHELIOIDA.

Genus

Lophohelia, *Ed. & H.*, p. 38.
Amphihelia, *Ed. & H.*, p. 39.
Enallohelia, *Ed. & H.*, p. 39.
Euhelia, *Ed. & H.*, p. 40.
Acrohelia, *Ed. & H.*, p. 40.
Astrohelia, *Ed. & H.*, p. 40.
Dendrohelia, *Etallon*, p. 41.

Alliance OCULINOIDA.

Genus

Oculina, *Ed. & H.*, p. 41.
Subgenus Agathelia, *Reuss*, p. 42.
Cyathohelia, *Ed. & H.*, p. 42.
Synhelia, *Ed. & H.*, p. 42.
Trymohelia, *Ed. & H.*, p. 43.
Sclerohelia, *Ed. & H.*, p. 43.
Bathelia, *Moseley*, p. 43.
Haplohelia, *Reuss*, p. 44.

Alliance PROHELIOIDA.

Genus

Prohelia, *E. de From.*, p. 44.

Alliance STYLOPHOROIDA.

Genus

Stylophora, *Ed. & H.*, p. 45.
Stylohelia, *E. de From.*, p. 45.
Madracis, *Ed. & H.*, p. 45.

III. Family POCILLOPORIDÆ.

Genus

Pocillopora, *Verrill*, p. 47.
Seriatopora, *Lmk.*, p. 47.

IV. Family ASTRÆIDÆ.

Subfamily *Astræidæ simplices.*

Alliance TROCHOSMILIOIDA.

Genus

Trochosmilia, *Ed. & H.*, p. 51.
Subgenus Epismilia, *E. de From.*, p. 52.
„ Cœlosmilia, *Ed. & H.*, p. 52.
Diplocteniuin, *Goldfuss*, p. 53.
Montlivaltia, *Lamour.*, p. 53.
Subgenus Leptomussa, *d'Ach.*, p. 54.
„ Oppelismilia, *Dunc.*, p. 54.
„ Ceratophyllia, *K. v. Fritsch*, p. 54.
Feddenia, *Dunc.*, p. 54.

Alliance PLACOSMILIOIDA.

Genus

Placosmilia, *Ed. & H.*, p. 55.
Lophosmilia, *Ed. & H.*, p. 55.
Subgenus Plesiosmilia, *Milas.*, p. 55.
Pleurosmilia, *E. de From.*, p. 56.
Peplosmilia, *Ed. & H.*, p. 56.
Blastosmilia, *Etallon*, p. 56.
Sphenophyllia, *Moseley*, p. 57.

Alliance LITHOPHYLLIOIDA.

Genus

Parasmilia, *Ed. & H.*, p. 58.
Dasmosmilia, *Pourt.*, p. 58.
Conosmilia, *Dunc.*, p. 59.

Genus

Lithophyllia, *Ed. & H.*, p. 59.
Circophyllia, *Ed. & H.*, p. 59.
Subgenus Leptaxis, *Reuss*, p. 60.
„ Antillia, *Dunc.*, p. 60.

Alliance ASTEROSMILIOIDA.

Genus

Asterosmilia, *Dunc.*, p. 61.
Stephanosmilia, *E. de From.*, p. 62.
Cyathosmilia, *T. Woods*, p. 62.
Pattalophyllia, *d'Ach.*, p. 62.

Group-genus

Axosmilia, *Ed. & H.*, p. 63.

Subfamily *Astræidæ reptantes.*

Alliance RHIZANGIOIDA.

Genus

Cylicia, *Ed. & H.*, p. 64.
Scolangia, *T. Woods*, p. 65.
Cryptangia, *Ed. & H.*, p. 65.
Rhizangia, *Ed. & H.*, p. 65.
Bathangia, *Keferst.*, p. 66.

Alliance ASTRANGIOIDA.

Genus

Astrangia, *Ed. & H.*, p. 66.
Subgenus Cœnangia, *Pourt.*, p. 67.
„ Phyllangia, *Ed. & H.*, p. 67.
Ulangia, *Ed. & H.*, p. 68.
Stylangia, *Reuss*, p. 68.
Colangia, *Pourt.*, p. 68.
Cladangia, *Ed. & H.*, p. 69.
Latusastræa, *d'Orb.*, p. 69.

Subfamily *Astræidæ gemmantes.*

Alliance CLADOCOROIDA.

Genus

Cladocora, *Ed. & H.*, p. 70.
Pleurocora, *Ed. & H.*, p. 71.

Alliance GONIOCOROIDA.

Genus

Goniocora, *Ed. & H.*, p. 71.
Rhabdocora, *Ed. & H.*, p. 71.

Alliance Dendrosmilioida.

Genus
Dendrosmilia, *Ed. & H.*, p. 72.
Pourtalosmilia, *Dunc.*, p. 72.

Alliance Stylosmilioida.

Genus
Stylosmilia, *Ed. & H.*, p. 72.
Stylocora, *Reuss*, p. 73.
Stylocora, *E. de From.*, p. 73.
Placophyllia, *d'Orb.*, p. 73.
Donacosmilia, *E. de From.*, p. 73.

Alliance Palæastræoida.

Genus
Heterophyllia, *M'Coy*, p. 74.
Battersbyia, *Ed. & H.*, p. 74.
Group-genus
Hexasmilia, *E. de From.*, p. 75.

Subfamily *Astræidæ cæspitosæ.*

Alliance Calamophyllioida.

Genus
Eusmilia, *Ed. & H*, p. 77.
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Aplosmilia, *d'Orb.*, p. 77.
Solenosmilia, *Dunc.*, p. 78.
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Calamophyllia, *Ed. & H.*, p. 78.
Pleurophyllia, *E. de From.*, p. 79.
Dendrocora, *Dunc.*, p. 79.
Dactylosmilia, *d'Orb.*, p. 79.
Hymenophyllia, *Ed. & H.*, p. 80.
Rhabdophyllia, *Ed. & H.*, p. 80.

Alliance Thecosmilioida.

Genus
Thecosmilia, *Ed. & H.*, p. 81.
Subgenus Cladophyllia, *Ed. & H.*, p. 81.

Alliance Mussaoida.

Genus
Trachyphyllia, *Ed. & H.*, p. 82.
Mussa, *Oken*, p. 82.

Subfamily *Astræidæ confluentes.*

Alliance Euphyllioida.

Genus
Euphyllia, *Ed. & H.*, p. 84.
Glyphophyllia, *E. de From.*, p. 84.
Rhipidogyra, *Ed. & H.*, p. 85.
Teleiophyllia, *Dunc.*, p. 85.
Desmocladia, *Reuss*, p. 85.

Alliance Eugyroida.

Genus
Dendrogyra, *Ehr.*, p. 86.
Pectinia, *Oken*, p. 86.
Eugyra, *E. de From.*, p. 87.
Pachygyra, *Ed. & H.*, p. 87.
Diploria, *Ed. & H.*, p. 87.
Stiboria, *Etallon*, p. 88.
Manicina, *Ehr.*, p. 88.
Mæandrina, *Ed. & H.*, p. 88.
Subgenus Cœloria, *Ed. & H.*, p. 89.
Leptoria, *Ed. & H.*, p. 90.
Mæandrastræa, *Ed. & H.*, p. 90.
Brachymæandrina, *Dunc.*, p. 90.
Stelloria, *d'Orb.*, p. 90.

Alliance Symphyllioida.

Genus
Symphyllia, *Ed. & H.*, p. 91.
Phyllogyra, *Tomes*, p. 92.
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Ulophyllia, *Ed. & H.*, p. 94.
Tridacophyllia, *Blainv.*, p. 94.
Colpophyllia, *Ed. & H.*, p. 94.
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Alliance Monticuloida.

Genus
Aspidiscus, *Kœnig*, p. 96.
Hydnophora, *Ed. & H.*, p. 97.
Monticulastræa, *Dunc.*, p. 97.

Subfamily *Astræidæ agglomeratæ fissiparantes.*

Alliance Favioida.

Genus
Dichocœnia, *Ed. & H.*, p. 99.
Barysmillia, *Ed. & H.*, p. 99.
Stenosmilia, *E. de From.*, p. 99.
Favia, *Oken*, p. 100.
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Alliance Goniastræoida.

Genus
Goniastræa, *Ed. & H.*, p. 102.
Lamellastræa, *Dunc.*, p. 102.
Aphrastræa, *Ed. & H.*, p. 102.
Septastræa, *d'Orb.*, p. 103.

Subfamily *Astræidæ agglomeratæ gemmantes.*

Alliance ORBICELLOIDA.

Genus
Heliastræa, *Ed. & H.*, p. 104.
Subgenus Ulastræa, *Ed. & H.*, [p. 105.
Brachyphyllia, *Reuss*, p. 105.
Cyathomorpha, *Reuss*, p. 105.
Phymastræa, *Ed. & H.*, p. 106.
Solenastræa, *Ed. & H.*, p. 107.
Subgenus Cyphastræa, *Ed. & H.*, p. 107.
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Alliance PLACOCŒNIOIDA.

Genus
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Placophora, *E. de From.*, p. 108.
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Alliance STYLINOIDA.

Genus
Stylina, *Ed. & H.*, p. 109.
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Psammocœnia, *Ed. & H.*, p. 110.
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Genus
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Alliance CYATHOPHOROIDA.

Genus
Cyathophora, *Mich.*, p. 112.
Areacis, *Ed. & H.*, p. 113.
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Alliance PENTACŒNIOIDA.

Genus
Pentacœnia, *d'Orb.*, p. 113.
Acanthocœnia, *d'Orb.*, p. 114.

Alliance ELASMOCŒNIOIDA.

Genus
Diplocœnia, *E. de From.*, p. 114.
Diplocœniastræa, *d'Ach.*, p. 114.
Diplothecastræa, *Dunc.*, p. 115.
Koilocœnia, *Dunc.*, p. 115.
Anisocœnia, *Reuss*, p. 116.
Heterocœnia, *Ed. & H.*, p. 116.
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Alliance ECHINOPOROIDA.

Genus
Echinopora (pars), *Dana*, p. 117.
Acanthopora, *Verrill*, p. 117.
Physophyllia, *Dunc.*, p. 118.
Group-genus
Galaxea, *Oken*, p. 118.
Group-genus
Leptastræa, *Ed. & H.*, p. 119.

Alliance BARYSASTRÆOIDA.

Genus
Barysastræa, *Ed. & H.*, p. 119.
Acanthastræa, *Ed. & H.*, p. 119.

Alliance ASTROCŒNIOIDA.

Genus
Astrocœnia, *Ed. & H.*, p. 120.
Cyathocœnia, *Dunc.*, p. 120.
Stephanocœnia, *Ed. & H.*, p. 121.
Narcissastræa, *E. Pratz*, p. 121.
Haldonia, *Dunc.*, p. 121.
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Alliance ISASTRÆOIDA.

Genus
Isastræa, *Ed. & H.*, p. 123.
Prionastræa, *Ed. & H.*, p. 123.
Placastræa, *Stolic.*, p. 124.
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Alliance LATIMÆANDROIDA.

Genus
Latimæandra, *Ed. & H.*, p. 125.
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Group-genus
Merulina, *Ehr.*, p. 128.

Alliance PLERASTRÆOIDA.

Genus
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Genus
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Group-genus
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Group-genus
Siderastræa, *Blainv.*, p. 134.
Group-genus
Polyaræa, *K. v. Fritsch*, p. 134.

Alliance Astræomorphoida.

Genus
Astræomorpha, *Reuss*, p. 135.
Mesomorpha, *E. Pratz*, p. 136.

Alliance Thamnastræoida.

Genus
Thamnastræa, *Lesauv.*, p. 138.
Subgenus Centrastræa, *d'Orb.*, [p. 139.
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Reussastræa, *d'Ach.*, p. 140.
Dimorphastræa, *d'Orb.*, p. 140.
Dimorphocœnia, *E. de From.*, p. 140.
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II. Family FUNGIDÆ.

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Genus
Fungia, *Dana*, p. 141.
Subgenus Haliglossa, *Ehr.*, p. 142.
Diafungia, *Dunc.*, p. 142.
Micrabacia, *Ed. & H.*, p. 143.

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Genus
Halomitra, *Dana*, p. 144.
Sandalolitha, *Quelch*, p. 144.
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Genus
Herpolitha, *Esch.*, p. 145.
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III. Family LOPHOSERIDÆ.

Subfamily *Lophoserinæ simplices.*

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Genus
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Gyroseris, *Reuss*, p. 147.
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Genus
Cycloseris, *Ed. & H.*, p. 149.
Diaseris, *Ed. & H.*, p. 150.
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Genus
Psammoseris, *Ed. & H.*, p. 152.
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Alliance Podoserioida.

Genus
Podoseris, *Dunc.*, p. 153.
Episeris, *E. de From.*, p. 154.
Group-genus
Gonioseris, *Dunc.*, p. 154.

Subfamily *Lophoserinæ aggregatæ.*

Alliance Cyathoserioida.

Genus
Cyathoseris, *Ed. & H.*, p. 154.
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Thamnoseris, *Etallon*, p. 155.

Alliance Pavonioida.

Genus
Lophoseris, *Ed. & H.*, p. 157.
Subgenus Haloseris, *Ed. & H.*, p. 157.
Tichoseris, *Quelch*, p. 157.
Mycedium, *Oken*, p. 158.
Phyllastræa, *Dana*, p. 158.
Trachypora, *Verrill*, p. 159.
Leptoseris, *Ed. & H.*, p. 159.
Protoseris, *Ed. & H.*, p. 159.
Subgenus Phylloseris, *Tomes*, [p. 160.

Alliance Stephanarioida.

Genus
Stephanaria, *Verrill*, p. 160.
Pratzia, *Dunc.*, p. 160.

Alliance Agaricioida.

Genus
Agaricia, *Lmk.*, p. 161.
Plesioseris, *Dunc.*, p. 161.
Psammocora, *Dana*, p. 192.
Pachyseris, *Ed. & H.*, p. 162.
Comoseris, *Ed. & H.*, p. 162.
Subgenus Oroseris, *Ed. & H.*, [p. 163.
Hydnophorabacia, *d'Ach.*, p. 164.
Coscinaræa, *Ed. & H.*, p. 164.

IV. Family ANABACIADÆ.

Genus
Anabacia, *d'Orb.*, p. 165.
Genabacia, *Ed. & H.*, p. 165.

V. Family PLESIOPORITIDÆ.

Alliance LEPTOPHYLLIOIDA.

Genus
Leptophyllia, *Reuss*, p. 166.
Subgenus Thecoseris, *E. de From.*, p. 166.
Trocharæa, *Etallon*, p. 167.
Haplaræa, *Milas.*, p. 167.

Group-genus
Cyclolites, *Lmk.*, p. 167.

Alliance MICROSOLENOIDA.

Genus
Microsolena, *Lamour.*, p. 168.
Polyphylloseris, *E. de From.*, p. 168.
Thamnaræa, *Etallon*, p. 169.
Diplaræa, *Milas.*, p. 169.
Disaræa, *E. de From.*, p. 169.
Dimorpharæa, *E. de From.*, p. 170.
Latimæandraræa, *E. de From.*, p. 170.
Mæandroseris, *Rouss.*, p. 170.

Group-genus
Mycetaræa, *Pratz*, p. 171.

III. Section *MADREPORARIA PERFORATA*.

I. Family EUPSAMMIDÆ.

Alliance STEPHANOPHYLLIOIDA.

Genus
Stephanophyllia, *Mich.*, p. 173.
Subgenus Discopsammia, *d'Orb.*, p. 174.
Leptopenus, *Moseley*, p. 174.
Cyclobacia, *Bölsche*, p. 174.

Alliance BALANOPHYLLIOIDA.

Genus
Balanophyllia, *S. Wood*, p. 175.
Subgenus Thecopsammia, *Pourt.*, p. 175.
Eupsammia, *Ed. & H.*, p. 176.
Endopachys, *Londs.*, p. 176.
Heteropsammia, *Ed. & H.*, p. 176.

Alliance DENDROPHYLLIOIDA.

Genus
Dendrophyllia, *Ed. & H.*, p. 177.
Subgenus Cœnopsammia, *Ed. & H.*, p. 178.
Placopsammia, *Reuss*, p. 179.
Astropsammia, *Verrill*, p. 179.
Pachypsammia, *Verrill*, p. 179.
Stereopsammia, *Ed. & H.*, p. 179.
Calostylis, *Lindstr.*, p. 180.

Alliance LEPTOPSAMMIOIDA.

Genus
Leptopsammia, *Ed. & H.*, p. 181.
Endopsammia, *Ed. & H.*, p. 181.

Group-genera
Astroides, *Blainv.*, p. 181.
Lobopsammia, *Ed. & H.*, p. 182.
Rhodopsammia, *Semper*, p. 182.
Rhizopsammia, *Verrill*, p. 182.

II. Family MADREPORIDÆ, *Ed. & H.* (pars).

Alliance MADREPOROIDA.

Genus
Madrepora, *Linn.*, p. 183.
Subgenus Isopora, *Studer*, p. 184.

Alliance TURBINARIOIDA.

Genus
Turbinaria, *Oken*, p. 184.
Astræopora, *Blainv.*, p. 185.
Dendracis, *Ed. & H.*, p. 185.
Actinacis, *d'Orb.*, p. 185.
Palæacis, *Haime*, p. 185.
Prisciturben, *Kunth*, p. 186.
Stylaræa, *Seebach*, p. 186.

III. Family PORITIDÆ.

Alliance PORITINOIDA.

Genus
Porites, *Ed. & H.*, p. 187.
Synaræa, *Verrill*, p. 187.
Napopora, *Quelch*, p. 188.
Dictyaræa, *Reuss*, p. 188.
Rhodaræa, *Ed. & H.*, p. 188.
Goniopora, *Quoy & Gaim.*, p. 189.
Litharæa, *Ed. & H.*, p. 189.
Protaræa, *Ed. & H.*, p. 189.
Alveopora, *Quoy*, p. 190.
Subgenus Favositipora, *Kent*, p. 190.
Somphophora, *Lindst.*, p. 190.
Dichoræa, *T. Woods*, p. 190.

Alliance MONTIPOROIDA.

Genus
Montipora, *Quoy*, p. 191.
Anacropora, *Ridley*, p. 192.

EXPLANATION OF TERMS.

Corallum. An entire solitary or individual coral.

Colony. A compound corallum of authors. A number of individuals united together. A number of corallites springing from a common stock.

Corallite. An individual member of a colony.

Common wall or *colonial theca* or *common plateau.* The structure which often environs the colony at the sides, or is at the base. It may be only found as a basal structure.

Corallite-wall or *Theca.* The external structure which gives the corallite its shape, bounds the visceral cavity and interseptal loculi, and to which septa are attached within and often costæ without. It is solid in the Aporosa, perforated in the Perforata and in some Fungida. Walls may be separate or fused together.

Calice. The upper opening of the corallite or corallum. A calice may be circular, elliptical, oval, elongate, deformed, or polygonal in outline. It may be separate from other calices in a colony, or more or less united with others by fusion of the walls of the adjacent corallites. The margin of the calice is the top of the corallite-wall.

The parts of the calice are—the septa, pali, the columella, the fossa, and interseptal loculi.

Septum. A typical septum is a lamina or plate, which reaches from the inner surface of the corallite-wall near or quite to the centre of the calice. It may reach any distance towards a central axial line. The upper edge is free at the calice, whilst the lower edge is fused with the lowest part of the corallite's cavity.

Septa may be few in number or very numerous. They may be solid, fenestrated, or perforated here and there, or reduced to mere trabeculæ and points. They may be entire at the upper edge, or ragged and denticulate there. They may unite with their fellows laterally or by means of the inner edge, but usually this is either free; or it may be united, directly or indirectly, with a columella or with pali. The spaces between the septa are interseptal loculi.

Septa are arranged in systems, and appear in cycles or orders. A typical Aporose coral has six systems, and the same number of septa in each.

The first septa which appear are the primaries, and there are six of them, so that a system is between two primaries. Next come the secondaries, six in number, one between each primary pair; so that there are then 12 septa, or each system has two cycles of septa, one composed of primaries and the other of secondaries. The tertiary septa appear between each secondary and a primary, in every system; so that there are 6 primaries, 6 secondaries, and 12 tertiaries, making three cycles, or 24 septa in all. The next cycle has its septa in the interval between the tertiaries and secondaries and tertiaries and primaries. The new septa are therefore 4

to each system, and in all 24. These, added to the previously existing 24, make 48 as the number of the entire four cycles of septa.

The fifth cycle has its septa in the intervals between the already existing septa, and when it is complete the number of all the septa in the corallite is 96. The sixth cycle, if complete, gives 192 septa.

The septa which arise simultaneously, in the different systems, are of the same *order*. There is not much occasion for this term until the fourth cycle of septa is considered. The septa often do not all arise spontaneously, and then the fourth and fifth orders become of importance.

There is some discrepancy of opinion regarding the exactitude of the statements of Milne-Edwards and Jules Haime, but this succession is in the main true, and especially in calices which are symmetrical and circular in outline. Ellipticity of outline appears to interfere with the normal increase of the septa, or abnormality develops the ellipticity.

In some genera the six systems do not occur, and the septa may be in 3, 4, 5, 6, 7, 8, 10 systems. In each of these systems, however, there may be a normal succession of septa. Occasionally septa abort; and, on the other hand, one or more may be unusually large.

Pali. Pali or paluli are laminæ or plate-like growths which extend upwards from the bottom of the corallite to the calice, where they usually project between the inner edge of certain septa and the columella or the axial space. They are placed before certain cycles or orders of septa only. There may be one or two sets or crowns or even more of them, as they are placed before (or between the centre of the corallite and the septal end) several cycles of septa. They differ in structure from the septa.

Columella. A structure which fills the axis of the corallite more or less. It may be solid, and may arise from the base of the corallite within, and reach up to the calice and end in a knob or point. It is then essential and styliform.

It may arise from the base, and be formed of ribbon-shaped laminæ more or less intertwisted, and reaching up to the bottom of the calice. Such a one is essential and trabeculate.

It may be made up of trabeculæ springing from the base and ending upwards with a spongy or papillary top. It is then essential, spongy, or papillary. Sometimes the columella arises from the junction in the middle line of processes or trabeculæ from the ends of the septa. It is then *not essential, but parietal.* This form may be very slight or rudimentary.

The essential columella may sometimes be a long solid lamella, and then the columella is said to be lamellar.

It may happen that there is no columella, and then the central axis is vacant.

Calicular axial fossa may be wide or narrow, circular or elongate. *Calicular fossa* is the depth of the whole calice.

Costæ. Projections upon the corallite or colonial wall or plateau-base with intercostal depressions or spaces. Usually the costæ correspond with the septa; but sometimes they relate to the interseptal space or differ in number. The costæ may be directly continuous with the septa at the calicular

margin, and may pass from calice to calice. When there is continuity, the costæ are termed septo-costæ. These may pass over the common wall and base.

Costæ do not exist in some genera; and, when they are developed, may be spinulose, moniliform, or smooth and lamellar. Some are crested and spined.

Endotheca or *Dissepiments.* Thin plate-like structures, oblique, arched, and more or less distant, one above the other, in the interseptal loculi, and sometimes, when there is no columella, in the axial space. They unite septa, close the loculi, enable the coral to grow in height and strength, and limit the growth downwards of the mesenteries and soft parts.

Tabulæ. Horizontal stout dissepiments, crossing much or all of the space within the corallite-walls.

Synapticula. Special growths from the septal sides, reaching over the interseptal loculi to the other septa. They occlude much of the interseptal loculi, often form a false basal wall to the corallite, and tend to form the mural and basal structures in some genera. They are false when they only consist of granular or papillary ornamentation united across the interspaces.

Exotheca. A cellular structure stretching between neighbouring costæ and filling up the intercostal spaces, and often extending beyond the costæ and uniting neighbouring corallites. When abundant, it forms a cœnenchyma. It may be in bands, or may be very thick, and yet vesicular; in this last instance it is termed *peritheca.*

Epitheca. A basal structure covering all the outer structures of a colony or corallum. It may reach close to the calice or only a little way from the base. It may resemble the wall itself, or be membranous or pellicular, and may be extended into radicles. It may be either smooth or transversely wrinkled.

Gemmation. This is rarely deciduous, and may arise from the calice—calicular gemmation. If from between the axis and the calicular margin—intercalicular gemmation; from the margin—marginal gemmation. Between calices—intracalicular gemmation. It may occur from any part of the wall of a corallite, from the calicular margin to the base—infra-marginal or lateral gemmation. It may be close to or at the base—basal gemmation. Sometimes it occurs from stolons, or soft or solid growths from the base.

Fissiparity. Union of septa across a calice and division of the corallite into two or more parts, which become separate individuals, or by a continuance of the process develop *series.*

Collines or *Ridges.* The raised parts of a colony between series of calices, usually covered by septo-costæ.

Stereoplasm. A term usefully introduced by Lindström. Delicate endothecal structure occupyiug different positions in the corallite, often forming vertical processes in the interseptal loculi, or encircling septa, or acting as true endotheca. Often filling up the base within, and then more solid.

The following 40 genera are now considered to be sub-genera :—

Acanthocyathus, *Ed. & H.*
Agathelia, *Reuss.*
Agelecyathus, *Dunc.*
Antillia, *Dunc.*
Blagrovia, *Dunc.*
Blanfordia, *Dunc.*
Blastotrochus, *Ed. & H.*
Caulastræa, *Dana.*
Ceratophyllia, *v. Fr.*
Cladophyllia, *Ed. & H.*
Cœloria, *Ed. & H.*
Cœlosmilia, *Ed. & H.*
Cœnangia, *Verrill.*
Cœnopsammia, *Ed. & H.*
Cyphastræa, *Ed. & H.*
Discopsammia, *d'Orb.*
Epismilia, *E. de From.*
Favositipora, *S. Kent.*
Haliglossa, *Ehr.*
Haloseris, *Ed. & H.*
Haplaræa, *Milas.*
Heliocœnia, *Etallon.*
Isopora, *Studer.*
Javania, *Dunc.*
Leptaxis, *Reuss.*
Leptomussa, *d'Ach.*
Oppelismilia, *Dunc.*
Oroseris, *Ed. & H.*
Palæoseris, *Dunc.*
Phyllangia, *Ed. & H.*
Phylloseris, *Tomes.*
Plesiosmilia, *Milas.*
Rhizotrochus, *Ed. & H.*
Stephanocyathus, *Seg.*
Stylotrochus, *E. de From.*
Thecocyathus, *Ed. & H.*
Thecoseris, *Ed. & H.*
Trocharæa, *Etall.*
Tropidocyathus, *Ed. & H.*
Ulastræa, *Ed. & H.*

The following 95 genera are either synonymous with others, or are necessarily absorbed, or of deficient value :—

Actinaræa, *d'Orb.*
Agathiphyllia, *Reuss.*
Amphiastræa, *Etall.*
Anomocora, *Stud.*
Aplocyathus, *d'Orb.*
Aplophyllia, *d'Orb.*
Aulopsammia, *Reuss.*
Axohelia, *E. de From.*
Bathycyathus, *Ed. & H.*
Blastocyathus, *Reuss.*
Blastosmilia, *Dunc.*
Brachytrochus, *Reuss.*
Brassyia, *Wright.*
Brevismilia, *Bölsche.*
Chorisastræa, *E. de From.*
Clemactis, *Agass.*
Cnemidium, *Quenst.*
Cœnastræa, *Etall.*
Cœnosmilia, *Pourt.*
Cœnotheca, *Quenst.*
Comophyllia, *d'Orb.*
Confusastræa, *d'Orb.*
Conotrochus, *Seg.*
Crispatotrochus, *T. Woods.*
Cyathophyllia, *E. de From.*
Cyclobacia, *Bölsche.*
Cylicosmilia, *Ed. & H.*
Cynarina, *Brügg.*
Dendraræa, *d'Orb.*
Dimorphoseris, *Dunc.*
Diplocœnia, *Dunc.* (*non E. de From.*).
Diplohelia, *Ed. & H.*
Echinophyllia, *Klunz.*
Ecmesus, *Phil.*
Ellipsocœnia, *d'Orb.*

Ellipsosmilia, *d'Orb.*
Epitrochus, *E. de From.*
Fiscicella, *Dana.*
Gyrosmilia, *E. de From.*
Hemicyathus, *Seg.*
Homophyllia, *Brügg.*
Hoplangia, *Gosse.*
Isocora, *Etall.*
Isophyllia, *Ed. & H.*
Koilotrochus, *T. Woods.*
Koninckia, *Ed. & H.*
Lobactis, *Agass.*
Meandraræa, *Etall.*
Metastræa, *Ed. & H.*
Microphyllia, *d'Orb.*
Microtrochus, *T. Woods.*
Notocyathus, *T. Woods.*
Oulophyllia, *Ed. & H.*
Ovalastræa, *d'Orb.*
Oxypora, *S. Kent.*
Oxysmilia, *Duch.*
Parastræa, *Ed. & H.*
Paterocyathus, *Duch. et Mich.*
Pavonia, *Lmk.*
Pentalophora, *S. Kent.*
Phyllodes, *Phil.*
Phyllogyra, *Tomes.*
Phyllopora, *T. Woods.*
Phyllosmilia, *E. de From.*
Placohelia, *E. de From.*
Platycyathus, *E. de From.*
Platygyra, *Ehr.*
Platyhelia, *E. de From.*
Pleuractis, *Agass.*
Pleurocœnia, *d'Orb.*
Pleurocyathus, *E. de From., Moseley, Keferst., Reuss.*
Plocophyllia, *Reuss.*
Podobacia, *Ed. & H.*
Psammohelia, *E. de From.*
Psammosmilia, *E. de From.*
Reussia, *Duch. et Mich.*
Scolymia, *Haime.*
Smilophyllia, *E. de From.*
Sphenopterium, *Meek.*
Stenogyra, *E. de From.*
Stephanastræa, *Etall.*
Stephanoseris, *E. de From.*
Stephanosmilia, *Reuss.*
Stylangia, *E. de From.*
Stylaræa, *Ed. & H.* (*non Seebach*).
Stylocyathus, *Reuss.*
Syzygophyllia, *Reuss.*
Tetracœnia, *d'Orb.*
Thalamocœnia, *d'Orb.*
Tiaradendron, *Quenst.*
Tricycloseris, *Tomes.*
Trismilia, *E. de From.*
Ulocyathus, *Sars.*
Undaria, *Dana.*
Vasilium, *T. Woods.*

Total genera as subgenera.........	40
„ „ abolished	95
Total......	135

Longicorn Beetles of Japan. Additions, chiefly from the later Collections of Mr. George Lewis; and Notes on the Synonymy, Distribution, and Habits of the previously known Species. By H. W. Bates, F.R.S., F.L.S.

(Read 5th June, 1884.)

[Plates I. & II.]

The present paper is essentially a supplement only to a former paper published on the same subject in the 'Annals and Magazine of Natural History' for 1873, vol. xii.; but it is a supplement which in extent greatly surpasses the original, the number of species of this conspicuous Coleopterous family recorded in the first paper being 107, and the present paper containing 129, making a total of 236 species now known as belonging to the Japanese Fauna in this department. This great accession to our knowledge is due almost entirely to the labours of Mr. Lewis and the native collectors directed by him, on his second visit to the islands in 1880–81. It is sufficient to glance at the two lists—the original one, published in 1873, and the following supplemental one—to see how large a proportion of the new species (and it is the same with the species known elsewhere now detected in Japan) is due to the labours of Mr. Lewis.

In the introductory paragraphs to my former paper I made a few remarks on the relations of the Fauna of Japan as regards the Longicornia to those of other regions, pointing out chiefly the very strong tropical element and the absence of many characteristic palæarctic genera. I have also discussed the question of faunistic relations in two other papers published on the Geodephagous Coleoptera of Japan. In my first enumeration of the Japanese Longicornia, I remarked that 21 genera out of the total of 64 were tropical genera, *i. e.* genera found nowhere but within the tropics. In the present supplement only 6 of the 57 genera added to the original 64 are known as tropical; but the number must be increased if we are to add the many absolutely new genera (such as *Leptoxenus*, *Pyrrhona*, *Corennys*, *Xenicotela*, &c.), which have tropical, and not palæarctic, affinities. Still, upon the whole, our supplementary list must be considered as diminishing the proportion of tropical forms in the Longicorn Fauna of Japan, a large number of European, Siberian, and North-

American genera (e. g. *Asemum*, *Tetropium*, *Rhagium*, *Encyclops*, *Pachyta*, *Grammoptera*, *Gaurotes*, *Strangalia*, *Necydalis*, *Rosalia*, &c.) having been now found, and many of the absolutely new genera having palæarctic or nearctic rather than tropical affinities. We know at present too little of the productions of the neighbouring regions of Asia (*i. e.* Corea, Manchuria, and Northern China), to discuss profitably the interesting problems which the Insect-fauna of Japan presents, such as its true relations to the neighbouring temperate parts of the Asiatic continent and the more distant tropics, and the derivation of the extraordinary number of endemic forms which it seems, especially as regards the Longicornia, to contain. Mr. Lewis's recent journey has shown, amongst other things, that the tropical forms are not confined to the southern part of the islands, nor the boreal forms to the northern part; from what we know of the same departments of the Fauna of Manchuria, tropical forms do not seem to extend northwards in the same way in continental Asia.

List of Species, supplemental to that published in the 'Annals and Magazine of Natural History,' vol. xii. (1873).

Fam. PRIONIDÆ.

Psephactus remiger, *Harold*.

Fam. CERAMBYCIDÆ.

Megasemum quadricostulatum, *Kraatz*.
Asemum amurense, *Kraatz*.
Tetropium luridum, *Linn*.
Neocerambyx Batesi, *Harold*.
Allotræus sphærioninus, *Bates*.
Leptoxenus ibidiiformis, *Bates*.
Rhagium inquisitor, *Linn*.
(*var.* japonicum).
Xenophyrama purpureum.
Lemula decipiens.
Encyclops olivaceus.
Omphalodera Puziloi, *Blessig*.
Pachyta erebia.
Gaurotes doris.
Toxotinus longicornis.
Grammoptera ægrota.
—— grallatrix.
—— signifera.
—— amentata.
—— chalybeella.
Leptura misella.
—— pyrrha.
—— succedanea, *Lewis*.
Leptura variicornis, *Dalm*.
—— granulata.
—— excavata.
—— cometes.
—— vicaria.
—— mimica.
—— subtilis.
—— thoracica, *Creutz*.
—— adumbrata.
—— nymphula.
Strangalomorpha ænescens.
Eustrangalis distenioïdes.
Strangalia dulcis.
—— contracta.
—— regalis.
Pyrrhona læticolor.
Corennys sericata.
Necydalis solida.
—— ebenina.
—— pennata, *Lewis*.
Aromia ambrosiaca, *Steven*.
Chloridolum thaliodes.
—— quadricolle.
Callichroma (?) japonica, *Harold*.
Rosalia Batesi, *Harold*.
Rhopalopus signaticollis, *Solsky*.
Semanotus chlorizans, *Solsky*.
Phymatodes Maaki, *Kraatz*.
Plagionotus pulcher, *Blessig*.

Clytanthus gracilipes, *Falderm.*
—— latifasciatus *Fischer.*
—— misellus.
—— xeniscus.
—— (?) —— acutivittis, *Kraatz.*
Demonax transilis.
Clytus melænus.
—— auripilis.
Xylotrechus chinensis (*Chevr.*).
—— emaciatus.
—— clarinus.
—— albifilis.
—— rufilius.
Brachyclytus singularis, *Kraatz.*
Anaglyptus niponensis.
Paraclytus excultus.
Aglaophis colobotheoïdes.

Fam. LAMIIDÆ.

Phlyctidola metallica.
Echthistatus binodosus, *Waterh.*
—— furciferus.
—— grossus.
Dolophrades terrenus.
Monohammus nitens.
—— grandis, *Waterh.*
—— pardalinus.
Haplohammus fulvicornis, *Pascoe.*
Uræcha griseola.
Mecynippus pubicornis.
Apalimna liturata.
Xenicotela fuscula.
Rhodopis integripennis.
Nanohammus rufescens.
Scotinauges diphysis, *Pascoe.*
Mesosa gracilior.
—— hirsuta.
—— senilis.
—— pœcila.
—— cribrata.
Mesosella simiola.
Sybra subfasciata.
Xylariopsis mimica.
Sydonia divaricata.
Graphidessa venata.
Eupogonius tenuicornis.
Terinæa atrofusca.
Cylindilla grisescens.
Rhopaloscelis unifasciatus, *Blessig.*
—— maculatus, *Bates.*
—— bifasciatus, *Kraatz.*
Eryssamena saperdina.
—— acuta.
—— spinidorsis.
Miccolamia cleroïdes.
—— verrucosa.
—— glabricula.
Clytosemia pulchra.
Acanthocinus stillatus.
Callapœcus guttatus.
Agapanthia angusticollis, *Gyll.*
Saperda decempunctata, *Gebler.*
—— tetrasticta, *Bates.*
—— sulphurata, *Gebler.*
—— octomaculata, *Blessig.*
Eutetrapha variicornis.
—— chrysargyrea.
Paraglenea chrysochloris, *Bates.*
—— eximia.
—— theaphia.
Glenea colenda, *Thomson.*
Singalia rufescens.
Stenostola argyrosticta.
—— anomala.
Epiglenea comes.
Oberea vittata, *Blessig.*
—— niponensis.
—— sericans.
Praolia citrinipes.

Fam. PRIONIDÆ.

PSEPHACTUS REMIGER, *Harold, Deutsch. ent. Zeitschr.* xxiii. (1879) p. 367, ♀. (Plate I. fig. 3. ♂)

♂. Minor et angustior; antennis haud longioribus, articulis 3–11 late (tertio latius) dilatatis et compressis; elytris adhuc brevioribus, segmentum primum ventrale paullo superantibus, supra crebrius reticulato-punctatis; tibiis posticis dilatato-compressis. Long. ♂ 16 millim., ♀ 25 millim.

Yezo, not rare. At Junsai found emerging in some numbers from a moss-grown stump.

The genus *Psephactus*, as Harold observed, is allied to *Tragosoma*. The genus of the Tragosominæ group to which it approaches the nearest is *Sarmydus*, Pascoe.

Ægosoma sinicum, *White*.

Found in Yezo and in Central Japan.

Fam. Cerambycidæ.

Megasemum quadricostulatum, *Kraatz*, *Berl. ent. Zeitschr.* xxiii. (1879) p. 97.

Chiuzenji, and South Yezo. Common in July and August. Described by Kraatz from East Siberia. Japanese examples are generally larger than the size (24 millim.) given by Kraatz, averaging 27 millim.

Asemum amurense, *Kraatz*, *Deutsch. ent. Zeitschr.* xxiii. (1879) p. 97.

Nikko.

Kraatz's brief description agrees with the Japanese specimens as far as it goes; but, if his species be really the same, the differences from the European *A. striatum* seem more important than he allows, the elytra being relatively more elongated and the thorax conspicuously different in its moderately rounded and not angulated sides.

Tetropium luridum, *Linn. Syst. Nat.* ed. xii. p. 634.

Tokio. One large specimen, long. 18 millim. The species is found throughout Northern and Central Europe and Siberia to the coast of Manchuria.

Neocerambyx chrysothrix, *Bates*, *Ann. & Mag. Nat. Hist.* ser. 4, xii. p. 152, ♀.

♂. A fœmina differt tantum antennis corpore fere duplo longioribus, articulisque 3–5 apice incrassatis.

Tokio.

The 3rd–5th joints of the antennæ are moderately clavate or thickened at their apices, the 5th slenderer than the two others and slightly longer than the 3rd.

Neocerambyx Batesi, *Harold*, *Abhandl. Nat. Ver. Bremen*, iv. p. 295 (1875).

Japan.

The description, drawn up from a male example, fits almost

exactly *N. chrysothrix* ♂, with the exception that the 3rd–5th antennal joints are not clavate (at least the author makes no mention of that feature) and the size much larger, 32 millim., *N. chrysothrix* measuring 25 millim. only.

PACHYDISSUS (MALLAMBYX) JAPONICUS, *Bates, Ann. & Mag. Nat. Hist.* ser. 4, xii. p. 152.—Neocerambyx Raddei, *Blessig, Horæ Soc. Ent. Ross.* ix. p. 170, t. vii. fig. 1.

Although the description and figure of Blessig do not exactly fit with regard to the outline of the thorax and the sutural apex of the elytra (especially in the female), there can be little doubt that the two names refer to the same species.

Central Japan; Yezo.

ALLOTRÆUS SPHÆRIONINUS, *Bates, Ent. Monthly Mag.* xiv. (1877) p. 37.

Hitoyoshi.

LEPTOXENUS IBIDIIFORMIS, *Bates, Ent. Monthly Mag.* xiv. (1877) p. 37.

Taken commonly as far north as Idzu.

STENYGRINUM QUADRINOTATUM, *Bates, Ann. & Mag. N. H.* ser. 4, xii. p. 154.

Ipongi, Japan. The species occurs also on the Khasia Hills.

DISTENIA JAPONICA, *Bates, Ann. & Mag. N. H.* ser. 4, xii. p. 155.—Apheles gracilis, *Blessig, Horæ Soc. Ent. Ross.* ix. p. 200, t. viii. fig. 1.

Blessig describes his species from a single example found at Port May, on the coast of Manchuria; his description and figure agree with the Japanese species, which is not generically different from *D. columbina*, Serv., the type of the genus. Blessig mentions as a chief character of *Distenia* silky hairs on the underside of the antennæ; but these do not exist in *D. columbina*, at least in the examples I have examined, and cannot besides be a generic character, as they are present or absent in species most closely allied in all other respects.

Central Japan; Yezo.

RHAGIUM INQUISITOR, *Linn.* (indagator, *Fab.*), var. JAPONICUM.

A typo differt elytrorum maculis fulvis discretis transversis

perparum confluentibus, fasciis duabus fulvis, sed fasciis fuscis plerumque vix perspicuis. Long. 12–16 millim.

Oyayama and Niohozan.

Presents a different appearance from the European *R. inquisitor*, owing to the tawny spots of the elytra being nearly always separate, exposing more of the shining brassy-black ground-colour. The spots in most examples are condensed into two widely separated fasciæ. A fascia of the dark ground-colour sometimes shows behind the second tawny belt. Examples, however, occur which do not differ from European specimens.

XENOPHYRAMA, nov. gen.

Gen. *Rhamnusio* (Latr.) approximans. Corpus oblongum. Caput quadratum, ante oculos parum elongatum (sed mandibulis elongatis), genis post oculos elongatis rectis vel postice subdilatatis, ab angulis oblique ad collum angustatis; collo parum constricto, vertice post antennas depresso, bituberoso, tuberibus (sicut tuberibus antenniferis) a linea dorsali profunda separatis; oculi subgrosse granulati sat profunde sinuati; tubera antennifera valida, elevata. Antennæ (♀) sat graciles fere corporis apicem attingentes, prope oculorum marginem anticam insertæ; articulis 3–4 conjunctis quam 5^{mus} vix longioribus, 5–11 filiformibus, æqualibus. Thorax amorphus: apud apicem angustus et sulcato-constrictus, deinde subito dilatatus et usque basin figuram cuboideam efficiens, dorso utrinque in tuber magnum, apice concavum, sicut inflatus; lateribus utrinque ante medium prominens; basi sulcato-depressus angulis posticis fere rectis. Elytra convexa sat late elongato-oblonga, apice late rotundata. Prosternum inter coxas angustissimum haud perspicuum, coxis valde exsertis. Pedes sat graciles, posticis relative haud longioribus, tarsis posticis brevibus, articulo primo lineari, quam 2–3 conjuncti longiori.

Although totally different in facies, due to the broad oblong elytra, opaque surface, longer antennæ, &c., this genus is undoubtedly allied to *Rhamnusium*.

XENOPHYRAMA PURPUREUM, n. sp. (Plate I. fig. 1.)

Nigrum, subnitidum; elytris rufo-purpureis, opacis, breviter incumbenti-pilosis, crebre subrugulose punctatis; capite thoraceque subtiliter sparsim punctulatis; scutello nigro, hirsuto; corpore subtus subtilissime punctulato et griseo-pubescenti. Long. 20 millim. ♂.

Yuyama; one example, June 1st, 1881.

TOXOTUS CÆRULEIPENNIS, *Bates.*

Taken in Yezo.

ENCYCLOPS OLIVACEUS, n. sp. (Plate I. fig. 7.)

Elongatus, linearis, olivaceo-æneus, subtiliter (capite thoraceque densius) griseo-pubescens, antennis pedibusque testaceo-rufis nigro-maculatis. Capite et thorace creberrime alveolatis, illo postice tumido-quadrato, oculis intus haud profunde sinuatis; hoc medio utrinque tuberculo conico, antice et postice parum constricto; disco modice convexo; elytris passim discrete punctatis; pectore argenteo-pubescenti. Long. 7½–10 millim.

Chiuzenji and Omine.

Differs from the North-American genus *Encyclops* only in the shallower emargination of the eyes. In this respect it agrees better with *Microrhabdium*, Kraatz, of E. Siberia; but Kraatz does not mention the finely faceted eyes, by his silence leaving it to be inferred that in his genus they are coarsely faceted, as is *Xylosteus*, *Psilorhabdium*, and *Leptorhabdium*, with which alone he compares it. The terminal joint of the palpi is short and strongly securiform, the antennæ are inserted nearly opposite the middle of the eyes; the tarsi are all slender, the first joint very elongated, in the hinder feet longer than the remaining joints taken together. The close, shallow, alveolate punctuation of the head and thorax speaks, in addition to other structural similarities, for the generic union of the species with *Encyclops*. The antennæ are red in their four basal joints, with the tips black (the scape having a long black streak), and black in the other joints with the base of each red. The legs are red, with a long spot on the femora, a smaller one on the tibiæ, and the tips of the tarsi black.

LEMULA, nov. gen.

Corpus minus elongatum, convexum. Caput post oculos quadratum, ante oculos breve; oculi prominentes intus haud emarginati subtiliter granulati. Antennæ media fronte contra oculi marginem anticum insertæ, corpore breviores, filiformes, articulis 3–4 subæqualibus, 4–11 paullo longioribus; palpi articulis ultimis haud dilatatis. Thorax utrinque tuberculo conico armatus; elytra apice obtuse rotundata, pygidium tegentia. Prosternum inter coxas nullum; mesosternum angustissimum. Pedes

parum elongati; femora gradatim sed parum incrassata; tarsi postici breves.

The species on which this genus is founded resembles a moderately slender *Lema*. It is distinguished from allied genera by the combination of characters furnished by the tumid-quadrate hind part of the head, entire eyes, antennæ inserted away from the eyes on an elevation in the middle of the forehead formed by the antenniferous tubercles, which are separated only by an impressed line, and the rather short legs.

Lemula decipiens, n. sp. (Plate I. fig. 5.)

Nigra; elytris, femoribus basi ventrisque apice, plus minusve fulvis, antennis rufo-fuscis. Capite et thorace nitidis sparsim pubescentibus disperse punctatis; illo medio linea impresso, hoc antice transversim profunde sulcato, postice depresso, disco bi-mamillato, sulco dorsali profundo; elytris passim crebre punctatis, nitidis, breviter setosis. Long. 5½–7 millim.

Hab. Miyanoshita; Kiga.

Omphalodera Puziloi, *Blessig, Horæ Soc. Ent. Ross.* ix. p. 245.

Var. Corpore subtus toto flavo (*O. flaviventris*).

Oyama; Miyanoshita; Nikko; Suyrma. Described by Blessig from R. Suifun, E. Siberia.

The Japanese examples differ from Blessig's description in having the abdomen constantly yellow instead of black. As they agree in all other points, I cannot but conclude this to be a slight local variation.

Pachyta erebia, n. sp.

♀. *Pachytis* typicis, elytrorum apicibus truncatis utrinque bidentatis, pertinet. Nigra, obscura, opaca, argenteo-griseo pubescens, elytris fere glabris; antennis, capite et thorace sicut in *P. quadrimaculata*; elytris apice latius truncatis, supra grossius et profundius confluenter subrugose punctatis, nigris vitta brevi (a medio usque prope apicem) intramarginali rufo-fulva. Long. 22 millim. ♀.

Chiuzenji; one example.

Gaurotes doris, n. sp.

G. ussuriensi (Blessig) proxime affinis et simillima, sed differt abdomine semper flavo basi et lateribus nigro-maculato. Supra læte æneus, viridi-æneus vel auratus fere glaber, nitidus, breviter

griseo-pubescens, subtus niger densius griseo-pubescens, abdomine flavo nigro-maculato; pedibus nigris nitidis; femoribus dimidio basali tibiisque (interdum) medio flavis. Capite creberrime thorace paullo parcius punctatis, elytris confluenter vel rugulose punctatis apice sinuato-truncatis utrinque bidentatis. Femora ♂ omnia, ♀ 4 posteriora subtus dentata. Long. 12–13 millim. ♂ ♀.

Chiuzenji; Niohozan.

Differs from *G. ussuriensis* (Blessig) of the Amur region only in the yellow colour of the abdomen, and would perhaps be better considered as a local variety of that species. It is, however, a larger and more brightly-coloured insect. The conspicuous tooth beneath the femora, similar to that of many *Donaciæ*, which both species wonderfully resemble, appears not to have been noticed by Blessig and Kraatz, the two authors who have mentioned *G. ussuriensis*: a specimen I obtained from probably the same source as those authors has femora like the Japanese form.

Toxotinus, nov. gen.

Facies gen. *Toxoti*. Caput post oculos elongatum paullulum tumidum sed vix ad collum angustatum, antice verticale. Oculi prominentes, parum emarginati, a mandibulis sat distantes, subtiliter granulati. Palpi apice minime dilatati. Antennæ ♂ ♀ corpore longiores, articulis 3–4 subæqualibus quam 5–10 paullo brevioribus, undecimo multo longiori, contra oculorum marginem anticum insertæ; tubera antennifera elevata. Thorax relative parvus conoideo-subcylindricus, antice et postice modice constrictus, tuberculo laterali utrinque obtuso, angulis posticis nullomodo prominentibus. Elytra postice paullo attenuata apice rotundata. Prosternum inter coxas angustissimum, mesosternum oblongum subconvexum. Pedes fere sicut in *Toxotis*, sed tibiis posticis apice multo minus oblique truncatis.

Distinguished from the allied genera by the form of the posterior part of the head and by the forehead being abruptly vertical from the base of the antennæ. The male resembles at first sight small individuals of the same sex of *Toxotus meridianus*.

Toxotinus longicornis, n. sp. (Plate I. fig. 6.)

Elongatus, postice modice angustatus dorso subplanatus, supra dense subtiliter aureo-pubescens, pube thoracis longiori, incumbenti, lætius aurato; subtus griseo-pubescens. Fulvus, capite,

scapo, thorace, sternis, coxis, trochanteribus femoribusque 4 posticis apice, nigris; capite thoraceque creberrime subalveolato-punctatis, elytris discrete punctulatis. Long. 12–14 millim. ♂ ♀.

Oyama; May 1880.

GRAMMOPTERA ÆGROTA, n. sp.

G. debili (Kraatz) proxime affinis. Pallide flavo-testacea, pubescens, elytris præcipue dense flavescenti-hirtis, antennarum articulis (a quarto) apice, femoribus tibiisque posterioribus apice, tarsorum articulis apice, nigro-fuscis; capite postice gradatim rotundato collo angusto, discreto punctulato, thorace sat angusto, versus apicem angustato, postice parallelogrammico angulis posticis subrectis, dorso valde convexo, sat sparsim subtiliter punctulato, linea dorsali brevi; elytris passim discrete punctatis, apice singulatim rotundatis. Long. 7–8 millim. ♂ ♀.

Nikko; Hitoyoshi, and other localities.

Kraatz describes the head and thorax of his *G. debilis* from East Siberia as "äusserst dicht und fein punctirt." Were it not for this clearly expressed character, I should have considered the present species the same as his; but the head and thorax in *G. ægrota* are very much less closely punctulate than is usual in the allied species; there are even wide spaces on the thorax, smooth and shining, without punctures. The species has slender antennæ and legs like *G. debilis*.

GRAMMOPTERA GRALLATRIX, n. sp.

G. gibbicolli (Blessig) affinis et quoad colores simillima, sed differt corpore, pedibus antennisque multo magis elongatis, elytris truncatis etc. Valde elongata, sublinearis, testaceo-fulva flavo-pubescens, vertice (et collo supra), pronoti disco, elytrorum fascia angusta suturali, altera interrupta marginali, femoribusque dimidio apicali, nigro-fuscis; antennis valde elongatis et gracilibus (articulo quinto cæteribus longiori, quarto breviori), articulis a quinto apice fuscis; capite post oculos breviter quadrato, paullo angustato sed angulis distinctis colloque abrupte angustato, genis apud angulos (ut supra visis) flavis; thorace sat angusto, lateribus ante medium haud prominentibus, disco rotundato-convexo; crebre alveolato-punctato, pube aureo-sericeo incumbenti læte vestito; elytris ♂ ♀ fere linearibus postice paullo angustatis, apice acute truncatis, extus angulatis, supra crebre punctatis;

pectore lateribus argenteo-pubescenti, metasterno extus fusco-nigro; tarsorum articulo unguiculari nigro. Long. 12 millim. ♂ ♀.

Nikko. Several examples of both sexes, exactly similar in colours and markings.

In *G. gibbicollis* the enlarged posterior part of the head is not tumid, but gradually narrowed, and the convexity of the thorax is compressed posteriorly; in *G. grallatrix* the posterior part of the head is distinctly quadrate and short, and the disk of the thorax forms an even convexity without compression. Both species are congeneric with *Acmeops ligata*, Lec., and other North-American species referred by American authors to the genus *Acmeops*.

GRAMMOPTERA SIGNIFERA, n. sp.

♀. *G. gibbicolli* iterum affinis. Paullo gracilior, nigro-fusca, partibus oris, clypeo, coxis femoribusque basi, testaceo-flavis; tibiis 4 anterioribus antennisque basi fusco-rufis, elytris utrinque vittis duabus (altera marginali altera discoidali) paullo ante apicem terminatis fasciaque ante apicem, fulvo-testaceis; capite et thorace creberrime punctatis, illo post oculos usque ad collum rotundato-angustato, hoc disco valde convexo, convexitate postice perparum compresso ibique pilis flavo-sericeis convergentibus; elytris (♂ ♀) sublinearibus apice truncatis (angulo exteriori rotundato), supra crebre sed discrete punctatis; abdomine fulvo, nigro-maculato. Long. 8–10 millim.

Var. ♀. Fascia ante-apicali deest (thoracis marginibus anticis et posticis scutelloque fulvis).

Var. ? ♂. Multo minor, vitta discoidali cum fascia conjuncta, pedibus (tarsis exceptis) toto fulvis. Long. 6–7 millim. ♂.

Var. ♀ (*G. mutata*). Elytra fulva, vitta angusta suturali ante apicem terminata (ibique macula triangulari), maculis tribus utrinque marginalibus apiceque nigris, thoracis marginibus anticis et posticis, antennis et pedibus fulvis. Long. 10 millim.

Var. ♀. Eadem: sed vitta suturali multo latiori, femoribus 4 posticis apice, antennis (basi excepta) nigris.

Nikko; Oyama; Hitoyoshi.

GRAMMOPTERA AMENTATA, n. sp.

G. signiferæ affinissima; differt capite post oculos recte angustato, postice (ante collum) distincte sed obtuse angulato, elytris ♀ apice singulatim rotundatis, ♂ obtusissime truncatis. Magis convexa, fusco-nigra, partibus oris, antennarum articulis basa-

libus pedibusque rufo-testaceis, femoribus apice tarsisque plerumque nigris; elytris plaga utrinque elongata maculas ovales fusco-nigras duas includenti, apicem haud attingenti, fulva. Long. 6–8½ millim. ♂ ♀.

Var. a. ♂ ♀. Elytrorum plaga fulva laterali usque ad apicem continuata maculas tres includenti.

Var. b. ♂ ♀. Elytris fulvis, sutura angusta maculisque utrinque tribus nigris; pedibus et interdum antennis pallide fulvis.

Miyanoshita; Suyama; Oyama; Chiuzenji.

GRAMMOPTERA CHALYBEELLA, n. sp.

G. ruficorni simillima. Gracilis, chalybeo-nigra griseo-pubescens, elytris subolivaceis nitidioribus et minus dense pubescentibus; antennis nigris, partibus oris, femoribus tibiisque anticis fulvo-rufis; thorace sicut in *G. ruficorni*. Long. 6–7 millim.

Nikko.

LEPTURA MISELLA, n. sp.

Ad § *Anoplodera* pertinet, sed corpore multo breviori fere sicut in *L. livida*. Subtus nigra, argenteo-griseo pubescens, supra nigra subopaca, nigro-setosa, elytris nitidis testaceo-fulvis, basi excepta nigro-marginatis, palpis et femoribus rufis (tibiis anticis rufescentibus); capite ante oculos parum prolongato sat lato, post oculos brevi, collo valde constricto, crebre subalveolato-punctato; thorace angusto postice haud constricto, sicut capite punctato; elytris relative brevibus dorso planatis, apice rotundatis, discrete punctatis; antennis filiformibus sat robustis, ♂ corpore longioribus, ♀ multo brevioribus. Long. 5½–7 millim.

Kashiwagi; Wada-togé.

The species is found also on the Amur, but is not noticed in Kraatz's excellent memoir on the Longicornia of that region.

LEPTURA PYRRHA, n. sp.

L. tesserulæ proxime affinis, differt solum elytris rubris immaculatis. Brevis, nigra subopaca, subtus griseo-pubescens, supra fulvo-hirta, elytris rufo-miniatis sat conspicue discrete punctatis subnitidis, apice oblique truncatis; thorace ænescenti-nigro, convexo, discrete punctato, juxta basin constricto et depresso; capite sicut in *L. tesserula*, postice brevi, angulato. Long. 11 millim.

Wada-togé; Nikko.

LEPTURA SUCCEDANEA, *Lewis, Ann. & Mag. N. H.* ser. 5, iv. p. 464.

Sapporo.

Mr. Lewis described the female only, mentioning the points in which it differs from the very closely allied European *L. rubra* (Linn.). The males of the two species differ more conspicuously, the thorax above in the Japanese form (except a transverse spot at the base) being tawny red, like the elytra, and in *L. rubra* black.

LEPTURA VARIICORNIS, *Dalman in Schönh. Syn. Ins.* i. 3. p. 482.

Niohozan.

Found also in Eastern Siberia and thence to North-eastern Europe. Besides typical specimens, Mr. Lewis took a single example of a black variety on Niohozan.

LEPTURA GRANULATA, n. sp.

Robusta, opaca, nigra, elytris obscure rufis; capite mox pone oculos constricto; thorace medio late rotundato, basi valde constricto angulis haud productis, disco convexo inæquali, cum capite grosse rugoso-punctato, pilis incumbentibus aureis; elytris modice elongatis et attenuatis, apice haud oblique sinuato-truncatis angulis acutis; tota superficie crebre granulata; subtus rugoso-punctulata tenuiter griseo-pubescens. Long. 17–23 millim. ♂ ♀.

Sapporo; Yani.

A large robust species, with thorax still more rounded on the sides than *L. proxima* (Say). The head behind the eyes is extremely short, showing only a small shining tubercle before the deep constriction of the neck. The pubescence is short and adpressed.

LEPTURA CYANEA, *Gebler, Nouv. Mém. Mosc.* ii. p. 70.

Niohozan. Widely distributed in Eastern Siberia.

LEPTURA EXCAVATA, n. sp.

L. cyaneæ affinissima sed differt corpore relative breviore coloreque toto nigro. Postice parum angustata, nigra, elytris subnitidis medio ad suturam concavis, pone scutellum margine utrinque valde elevato, apice recte truncatis, angulo exteriori rotundato, suturali acuto, sat grosse et crebre (versus apicem

subtilius) punctatis; thorace quam in *L. cyanea* paullo breviori lateribus perparum rotundatis, basi modice constricto, angulis haud prominentibus, disco convexo crebre foveolato, erecte piloso; antennis pedibusque breviter pilosis. Long. 12 millim.

Wada-togé; Niohozan.

Leptura (Judolia) cometes, n. sp.

L. cordiferæ (Oliv.) affinis: major, dense fulvo-pubescens, nigra opaca, elytris testaceo-flavis, basi juxta scutellum, macula subrotunda utrinque laterali (post medium) alteraque apicali, nigris; thorace campanuliformi, basi depresso, angulis maxime productis, dorso creberrime punctato dense erecte pubescenti; elytris sicut in *L. cordiferæ* apice singulatim productis subacutis, densissime sericeo subincumbenti-pubescentibus. Long. 15 millim.

Chiuzenji; Niohozan; Sapporo.

Approaches the North-American *L.* (*Judolia*) *cordifera* more nearly than any of the European species, having similarly prolonged apices of the elytra; but it is very much larger, and wants the anterior marginal spot of the elytra. The glossy tawny-golden pubescence on the elytra conceals, in certain lights, the black spots.

Leptura (Stenura) vicaria, n. sp.

L. obliteratæ (Haldem.) quam proxime affinis; differt statura longiori et graciliori, tibiisque posticis (♂) nigris etc. Nigra, fulvo-aureo pubescens; capite antice testaceo-flavo, macula triangulari frontali epistomateque nigris; thorace utrinque paullo ante medium tuberculo conico, crebre punctulato, fulvo-testaceo plaga magna dorsali nigra; elytris quam in *L. obliterata* longius attenuatis, basi relative angustioribus, apice oblique sinuato-truncatis utrinque bidentatis, flavis, apice late, fascia recta mediana maculaque parva versus basin laterali, nigris; antennis (♂) corporis apicem fere attingentibus, nigris, scapo subtus articulisque apicalibus basi flavis; pedibus flavo-testaceis, tibiis posticis (♂) femoribusque (basi excepta) nigris.

♂. Tibiis posticis dimidio basali flavis; elytris apice flavis (fascia subapicali nigra); antennarum articulis omnibus (a quarto) pallidis.

Long. 17–20 millim. ♂ ♀.

Niohozan and Sapporo; on flowers of Hydrangea.

LEPTURA (STENURA) MIMICA, n. sp.

L. arcuatæ affinissima, differt tantum antennis longioribus, coloribus signaturisque paullo diversis.

♂. Nigra, pube incumbente, supra fulvo-aurea, subtus argentea, vestita; elytris utrinque fasciis sat tenuibus flavis quatuor—prima virguliformi juxta scutellum (ramo exteriori curvato deficienti), secunda, tertia et quarta sicut in *L. arcuata*; antennis articulis 7–11 fulvis.

♀. Elytris fulvis, margine angusto basali et suturali, maculis rotundatis utrinque duabus (prima versus humeros interdum divisa, secunda majori apud medium) fasciisque duabus (prima ante apicem, secunda apicali) nigris; antennis fulvis, scapo paullo obscuriori; pedibus nigro-fuscis, tibiis et tarsis 4 anterioribus fulvis.

Long. 15–17 millim.

Var. ♂. Elytris nigris, maculis parvis duabus basalibus, altera medio basis, altera subhumerali.

Sapporo; Junsai; Nikko. The variety is from Nikko.

Scarcely more than a local variety of the European *L. arcuata*, which is found with little variation throughout Eastern Siberia to the coast of Manchuria. The Japanese form differs from European and Siberian examples chiefly in the basal fascia of the elytra in the male wanting the outer horn of the bow, and in the first and second black fasciæ in the female being widely detached from the suture. The antennæ are longer, and the thorax more angulated on the sides.

LEPTURA (STENURA) SUBTILIS, n. sp.

L. quadrifasciatæ (L.) affinis et similis, sed differt thorace basi multo latiori lateribusque subrectis haud sinuatis etc. Nigra, subnitida, elytris fasciis angustis quatuor suturam attingentibus et versus marginem angustatis; antennis subserratis; thorace triangulari multo subtilius punctato, fulvo-aureo pubescenti; elytris subtilissime punctulatis et rugulosis apice recte truncatis, angulis acutis, exteriori producto spiniformi. Long. 17 millim. ♂.

Chiuzenji, August 1881.

Differs from *L. quadrifasciata*, which occurs throughout Eastern Siberia as well as Northern and Central Europe, by definite specific characters; the thorax being regularly and straightly dilated from the fore margin to the hind angles, the angles of the elytral truncature spined, and the yellow fasciæ different in form.

Leptura (Stenura) thoracica, *Creutzer, Ent. Vers.* p. 125; *Fabr. Syst. El.* ii. p. 356.

Var. Corpore toto nigro.

Sapporo.

This species ranges from North-eastern Europe to Manchuria, offering on the Amur some variations of colour from the European type-form; but, as far as I am aware, no examples entirely black have been found on continental Asia.

Leptura (Stenura) adumbrata, n. sp.

Elongata, nigro-fusca, pube fulvo-sericea dense vestita, elytris utrinque plaga indistincta humerali, macula apicali, fasciisque angustis obliquis duabus (altera ante, altera post medium) fulvo-testaceis pube obscuratis; femoribus anticis abdominisque marginibus fulvis; antennis tenuibus, articulis apicalibus fulvis; thorace elongato-campanuliformi, lateribus fere rectis, angulis posticis valde elongatis; elytris basi latis, apice oblique sinuato-truncatis, angulo exteriori longe producto, subtiliter discrete punctulatis. Long. 17 millim. ♀.

Tokio; one example.

A species remarkable for the breadth of the elytra at the base, whence they are rapidly and straightly narrowed to the apex, and the dense, not closely adpressed, pile which obscures the yellow markings. The antennæ are unusually slender, more so than in *L. obliterata*.

Leptura (Stenura) nymphula, n. sp.

Minor, gracilis, nigra, subtus argenteo-sericea; elytris flavescenti-fuscis fulvo-hirtis, vitta interrupta marginali lineolisque indistinctis discoidalibus (versus basin) nigris; antennis (♂ corpore multo longioribus) versus apicem paullulum crassioribus nigris, articulis 9–10 octavoque apice albis; capite mox pone oculos constricto, grosse discrete punctato; thorace gracile campanuliformi, antice sulcato-constricto, basi vix depresso, angulis posticis parum productis, dorso discrete subtiliter punctato, linea dorsali lævi; elytris apice oblique truncatis, discrete punctulatis; pedibus nigris, quatuor anticis plus minusve testaceis. Long. 9–12 millim.

Var. Pallidior; antennis articulis 4–8 et 11mo basi flavis, elytris fulvescenti-flavis, vitta marginali nigra latiori (maculas

duas flavas includenti), lineolis discoidalibus nullis; abdomine testaceo-rufo.

Chiuzenji; Niohozan; Wada-togé. The var. Wada-togé.

STRANGALOMORPHA ÆNESCENS, n. sp.

A *S. tenui* (Blessig) differt thorace angulis posticis acutis, antennis nigris, etc. Sublinearis, nigra obscura, pube adpressa argentea (subtus dense) vestita, elytris olivaceo-æneis vel chalybeis subnitidis; genis post oculos sat prolongatis angulatis, capite toto creberrime punctato, linea mediana usque ad collum impressa; thorace campanuliformi, antice sulcato-constricto, postice modice depresso, angulis paullulum productis, dorso creberrime punctulato linea dorsali postica lævi; elytris crebre ruguloso-punctatis, apice vix oblique, subrecte truncatis. Segmento ultimo ventrale ♂ apice rotundato; ♀ latiori, medio sinuato. Long. 11–12 millim. ♂ ♀.

Chiuzenji; Niohozan; Wada-togé.

Apparently very closely allied to *S. tenuis* (Blessig), but differing in the concolorous antennæ, the denser punctuation of the elytra (in *S. tenuis* "ziemlich stark aber nicht sehr dicht punktirt"); it is also less linear in form, judging from the expressions used in the description of *S. tenuis*.

The genus *Strangalomorpha*, proposed by Blessig (Horæ Soc. Ent. Ross. ix. p. 253), differs from the subgenus *Stenura* in the form of the elytra, which are less narrowed behind and are depressed along the suture. I do not see the difference in the position of the base of the antennæ mentioned by Blessig. The antennæ are more slender than in *Stenura*, in both sexes being longer than the body.

EUSTRANGALIS, nov. gen.

Lepturæ (§ *Stenuræ*) affinis: differt thorace antice et postice sulcato-constricto medioque utrinque tuberculato. Corpus valde elongatum, postice attenuatum, subglabrum, nitidum. Caput ante oculos sat elongatum quadratum, post oculos subito angustatum. Oculi subtiliter granulati. Antennæ ad oculorum marginem anticam insertæ, sat robuste filiformes, versus apicem subincrassatæ. Thorax subconicus, antice et postice transversim profunde sulcatus, lateribus utrinque medio tuberculo valido, conico, angulis posticis haud productis. Elytra basi lata, humeris fere acuta, parum convexa, apud suturam usque ad

apicem concava fere sulcata, apice valde oblique et sinuatim truncata, angulo suturali sat elongato acuto, exteriori longe producto. Pedes postici relative parum elongati. Coxæ anticæ et sterna normalia. Ventris segmentum apicale in utroque sexu apice paullo sinuatum, ♂ haud medio concavum.

EUSTRANGALIS DISTENIOIDES, n. sp. (Plate I. fig. 4.)

Nitida, fulva, vertice thoracis macula utrinque discoidali, elytrorumque utrinque vitta ab humero usque ad apicem, nigris; antennis nigris; tarsis tibiisque posticis apice infuscatis. Capite punctato fere glabro; thorace punctulato, sulcis fundo lævibus, disco fulvo-aureo pubescenti; elytris sat crebre punctulatis, pilis fulvo-aureis incumbentibus sat sparsim vestitis; corpore subtus fere glabro nitido; abdominis segmento terminali nigro. Long. 15–20 millim. ♂ ♀.

Nikko; Sapporo.

STRANGALIA DULCIS, n. sp.

Valde elongata, gracilis, sericeo-opaca, nigra, thorace sanguineo; scutello dense aureo-pubescenti, elytris humeris et apice rufescentibus.

Variat: 1. Elytris castaneo-rufis. 2. Idem, thoraceque nigro.

♂. Segmentum apicale ventrale medio longitudinaliter concavum, lateralibus modice elevatis.

♀. Segmentum apicale parum concavum, lateribus haud elevatis.

Long. 15 millim. ♂ ♀.

Wada-togé; Yuyama, in Higo.

Of very elongate sublinear form, minutely and closely punctured, with fine incumbent pilosity and the surface almost opaque. The muzzle is moderately elongated and quadrate, the antennæ set a little behind the front margin of the eyes, and the head narrowed immediately behind the latter, a minute portion only of the cheeks being visible behind the eye. The thorax is narrow; widened from apex to base, the middle of the sides feebly dilated, the hind angles produced, the anterior sulcus well pronounced, but no depression across the middle of the base. The elytra are relatively narrow at the base, the apex very obliquely truncated, the surface without visible depression near the suture. The legs are long and slender, the hind pair remarkably long.

The species is intermediate between *Stenura* and *Strangalia*; the groove or concavity along the apical half of the last ventral

segment in the ♂ is, however, sufficiently marked to bring it within the definition of the latter genus.

STRANGALIA CONTRACTA, n. sp.

Angusta, elytris abbreviatis et postice valde angustatis; nigra, subtus cinereo-pubescens, elytris testaceo-fulvis lateribus (suturaque interdum) nigris; antennis pedibusque flavo-testaceis, illis articulis apice fuscis, vel fuscis basi flavis, femoribus posticis apice tibiis tarsisque nigris. Capite crebre punctulato post oculos cito rotundato-angustato; thorace elongato, basi modice dilatato, angulis parum productis, punctulato griseo-pubescenti (variat linea dorsali maculaque laterali fulvis); elytris sat sparse punctatis, apice obtuso truncatis. ♂ Segmento apicali ventrali elongato, apice late truncato, medio concavo lateribus postice elevatis. Elytris multo abbreviatis, segmentum antepenultimum vix transcendentibus. Long. 10–11 millim. ♂ ♀.

Kashiwagi; Niohozan and Wada-togé.

Resembles the Rhinotraginæ and many species of *Ophistomis* in the form of the elytra, strongly narrowed from before the middle, slightly dehiscent at the apex and abbreviated—peculiarities more pronounced in the ♂ than the ♀, in which latter sex they leave only the pygidium uncovered, whilst in the ♂ they reach barely beyond the antepenultimate segment, and are also depressed along the suture.

Variable in colours: the abdomen is either wholly black or black and reddish testaceous; the lateral black vitta of the elytra emits generally two short branches near the base, but these are sometimes wanting.

STRANGALIA REGALIS, n. sp.

Magna, robusta, subtiliter discrete punctulata, dense suberecte breviter pilosa, vix nitida, subtus aureo-pubescens; antennis brevibus, robustis (♂ corporis dimidium parum excedentibus). Thorace campanuliformi, ante medium subangulato, post medium longe sinuato, angulis posticis valde productis, antice sulcato-constricto, medio basi curvatim sulcata; elytris convexis, valde elongatis, basi modice latis, apice transversim late sinuato-truncatis utrinque bispinosis.

♂. Segmentum ultimum ventrale valde concavum, lateribus elevatissimis, dilatatis. Nigra, elytris utrinque maculis parvis prope suturam quatuor in loco fasciarum sitis, prima prope basin,

secunda ante, tertia post, medium, quarta ante apicem. Pedes 4 anteriores plus minusve rufi.

♀. Segmentum ultimum ventrale elongato-triangulare, apice emarginatum. Fulvo-aurantiaca; thorace antice et postice nigro-marginato, elytris fasciis quatuor nigris; vel nigra, elytris nigris, fasciis (interdum interruptis) quatuor fulvis, pedibus antennisque plus minusve nigricantibus.

Long. 26–30 millim. ♂ ♀.

Sapporo; Iga, on birch stumps.

Pyrrhona, nov. gen.

Corpus elongato-oblongum, parum convexum. Caput sicut in *Lepturis* veris, ante oculos modice elongatum quadratum; genis post oculos sat elongatis angulatis, collo constricto. Palpi apice cylindrici. Oculi subtiliter granulati. Antennæ corpore multo breviores, filiformes, robustæ, articulis 3–4 conjunctis quam 5m haud longioribus. Thorax relative parvus, subcampanuliformis, lateribus fere rectis, angulis posticis acutis parum productis, antice transversim sulcatus postice depressus. Elytra rectilatera, apice late rotundata. Pedes graciles, femora paullulum clavata. Coxæ anticæ tarsique postici sicut in *Lepturis*.

A distinct genus of the Lepturinæ group, differing from other genera, except *Pyrotrichus* (Leconte), in the great abbreviation of the third and fourth antennal joints, and from that genus in the unarmed thorax.

Pyrrhona læticolor, n. sp. (Plate I. fig. 8.)

Sanguinea, subopaca, dense erecte pubescens, subtus antennis pedibusque (tarsis rufescentibus) nigris. Capite et thorace creberrime punctulatis, illo linea mediana subtili impressa ab epistomate usque ad collum; elytris minus crebre punctatis. Long. 13 millim.

Yuyama.

Corennys, nov. gen.

Gen. *Pyrocalymmæ* (Thoms.) affinis. Corpus sublineare, supra pube læte sericea, diverse adpressa, vestitum. Caput ante oculos parum elongatum, latum; genis post oculos elongatis, latis, tumidis, collo subito maxime constricto. Oculi subtiliter granulati. Antennæ dimidio corporis parum longiores, intra oculos insertæ, robustæ, ♂ articulis 1–5, ♀ 1–8 dense hirsutis, 3–6 longitudine æqualibus, 6–11 ♂ cylindricis, 9–11 ♀ oblongis. Thorax relative

parvus, inermis, subcylindricus, postice dilatatus, angulis posticis subproductis sed apice obtusis, dorso convexus, antice et postice transversim sulcato-depressus. Elytra elongata, oblongo-linearia, basi recta, apice rotundata, dorso pluricostata. Pedes haud elongati, femora subclavata, tarsi breves, posteriorum articulo primo 2–3 conjunctis parum longiori. Prosternum inter coxas conspicuum sed valde angustum, marginatum. Coxæ sicut in *Lepturis* elongatæ, exsertæ. Mesosterni acetabula extus late aperta. Metasternum haud convexum; episternum postice attenuatum.

Allied to the Himalayan genus *Pyrocalymma*, and differing from it only in the form and clothing of the antennal joints, those in *Pyrocalymma* (♀) being broadly triangular, prolonged at their inner apical angles, and destitute of long hairs. Both genera agree in the margined prosternum. The antennæ in *Corennys* much resemble those of *Eroschema*; but they are not essentially different from the same organs in *Euryptera*.

CORENNYS SERICATA, n. sp. (Plate I. fig. 2.)

Nigra, supra creberrime punctulata, pilis longis sericeis incumbentibus fulvis, purpureis vel sanguineis dense vestita, subtus et in pedibus nigra nitida, antennis nigris; genis tumidis post oculos glabris, a vertice linea impressa separatis.

Long. 12½–17 millim. ♂ ♀.

Nanai; Chiuzenji; Ontaki, in flowers of *Viburnum*.

NECYDALIS SOLIDA, n. sp.

♀. *N. majori* quoad colores similis, sed major, præcipue latior, thorace haud cylindrico, postico dilatato, etc. Robusta, capite thoraceque nigris supra politis, elytris castaneo-rufis, antennis pedibusque fulvo-rufis, illis versus apicem infuscatis, femorum posticorum clava supra nigra, abdomine fulvo-rufo apice fusco; capite ante oculos brevissimo et latissimo, crebre punctulato; thorace erecte piloso subtilissime punctulato; elytris basi sparsius, apice crebrius et subtilius, rugoso-punctatis, apice pubescentibus; alis fulvo-hyalinis. Long. 30 millim. ♀.

Chiuzenji.

NECYDALIS EBENINA, n. sp.

Toto nigra, nitida. Capite sat crebre vertice confluenter punctato; thorace vix cylindrico, basi paullo latiori, ibi et lateribus crebre punctato, disco lævi, versus apicem profunde sulcato-

constricto; elytris æqualiter sat grosse punctatis, erecte breviter pilosis nec sericeo-pubescentibus; alis nigro-hyalinis.

Long. 22 millim. ♂ ♀.

Yezo, at Yunsai.

NECYDALIS PENNATA, *Lewis, Ann. & Mag. N. H.* ser. 5, iv. p. 464.

Nikko; also in Yezo.

THRANIUS VARIEGATUS, *Bates*.

Described originally from a single example taken at Nagasaki; since taken in some abundance by Mr. Lewis in Yezo.

AROMIA AMBROSIACA, *Steven, Mem. Mosc.* ii. p. 40.

Hakodate (*Mr. Ota*). One example, closely resembling specimens from Asia Minor, differing only in being somewhat smaller and apparently more slender.

CHLORIDOLUM THALIODES, n. sp.

Aromiæ moschatæ quoad colores simile, sed antennis et pedibus valde elongatis, femoribus 4 posterioribus longis parum incrassatis. Elongatum, postice parum angustatum, planatum, fere glabrum vix nitidum; supra saturate viride (thorace subcyaneo), subtus viridi-æneum tenuiter auro-sericeum, antennis pedibusque subviolaceis. Capite et thorace subgrosse intricato-rugulosis, tuberculis antenniferis oblique conicis nec spinosis; elytris subtiliter intricato-rugulosis; tibiis posticis compressis sublinearibus; scapo grosse punctato, antice sulcato, apice dentifero. Long. 27–32 millim. ♂ ♀.

Sapporo; Kobe.

A typical *Chloridolum*, according to the definition of the genus by its founder, and allied to *C. alcmene* (Thoms.) and *C. nympha* (White). The surface of the thorax and the vertex differs from that of the allied species in being coarsely and distinctly vermiculate rugose, with the transverse rugæ near the apex irregular. The antennæ in the ♂ are about twice the length of the body. The hindmost tarsi are much narrower and longer than in *Aromia moschata*.

CHELIDONIUM QUADRICOLLE, n. sp.

A *Ch. argentato* (Dalm.) differt corpore magis depresso, antennis articulis 7°–10^{m} apice extus productis, sed haud spinosis, thorace ante spinam rectangulato, etc. Valde elongatum sat depressum,

subopacum, læte æneo-viride, subtus splendidum, pectore aureo-pubescenti, antennis pedibusque violaceis; scapo haud sulcato, apiceque obtuso, tuberibus antenniferis sat acutis; collo et thorace toto grosse scabroso-punctatis, hoc transverso, basi et apice sulcato, lateribus mox pone sulcum dilatatis, margine angulato, spina mediana magna valida; elytris creberrime rugu-loso-punctatis subglabris, pube fulva parce vestitis, obsolete bicostulatis.

Antennæ breves, in utroque sexu corpore multo breviores, articulis 7°–11m apice extus productis acutis. Long. 22–27 millim. ♂ ♀.

Nara; Junsai; Sapporo; Tokio.

The thorax is broader and anteriorly much more angulated, and the antennal joints less produced at their apex (not spiniferous) than in any described species of *Chelidonium*; but the species fits better in this genus than in any other of the Callichrominæ group. The middle femora, as in the typical species, are short and strongly clavate.

CALLICHROMA JAPONICA (*C. japonicum*), *Harold*, *Stett. ent. Zeit.* 1879, p. 335.

Japan (*Hilgendorf*).

Harold does not describe the antennæ or the form of the middle femora.

ROSALIA BATESI, *Harold*, *Berl. ent. Zeitschr.* 1877, p. 360.

Yezo. Mr. Lewis took it abundantly in August and early September on the trunks of large standing beech-trees which had been stripped of their bark. One example taken at Buno near Nikko, August 30, 1881.

SYMPIEZOCERA JAPONICA, *Bates*.

Yokohama; at dusk, March 26, 1880, running over decayed Cryptomerias.

It is the first Longicorn to appear in spring.

RHOPALOPUS SIGNATICOLLIS (*Solsky*), *Blessig*, *Horæ Ent. Soc. Ross.* ix. p. 177.

Sapporo. Recorded by Blessig from Suifun, E. Siberia.

SEMANOTUS CHLORIZANS, *Solsky*, *Horæ Soc. Ent. Ross.* vii. p. 384.

Sapporo. Also on the Upper Amur.

Phymatodes albicinctus, *Bates, Ann. & Mag. N. H.* ser. 4, xii. p. 198 (1873).—Callidium albofasciatum, *Motschulsky, Bull. Mosc.* 1866*, i. p. 174; *Kraatz, Deutsche ent. Zeitschr.* 1879, p. 88.

Motschulsky's name has the priority over mine for this species, unless it be considered invalidated by its prior use by Bland for a North-American species (Proc. Ent. Soc. Phil. i. 1862, p. 274).

Phymatodes Maaki, *Kraatz, Deutsche ent. Zeitschr.* 1879, p. 88 (*Callidium*).—Callidium alni, *Linn.*? *Blessig, Horæ Soc. Ent. Ross.* ix. p. 182.

Chiuzenji; Oyayama.

Recorded by Blessig from the Middle Amur. Mr. Lewis's examples agree well with Blessig's description with regard to their differences from *Callidium alni*, except that the underside is not wholly pale reddish, the prosternum and abdomen being piceous. The species is very much larger than *C. Alni*, varying from 7–10 millim.

Plagionotus pulcher, *Blessig, Horæ Soc. Ent. Ross.* ix. p. 184, t. viii. fig. 2.—Clytus lignatorum, *Thieme, Berl. ent. Zeitschr.* 1861, p. 100.

Junsai. Does not differ from the East-Siberian insect, which occurs on the Amur, in the Bureja Mountains, and on the coast at Port May.

Clytanthus gracilipes, *Falderman, Mém. Acad. Pétrop.* ii. 1835, p. 436 (*Clytus*); *Kraatz, Deutsche ent. Zeitschr.* 1879, p. 91.

Fukushima. Widely distributed in Eastern Siberia, from the Altai to the Amur.

Clytanthus latifasciatus, *Fischer, Bull. Mosc.* iv. p. 439.

Sapporo.

One example, referred to this widely distributed East-Siberian species. It differs somewhat from a Manchurian specimen with which I have compared it, the oblique subbasal fascia curving sharply forward and joining the subbasal discoidal spot.

Clytanthus misellus, n. sp.

C. plebejo proxime affinis. Minor, gracilior, niger, thorace cinereo-pubescenti, basi utrinque albo marginata; scutello nigro;

* Kraatz gives the date erroneously as 1861.

elytris fascia a scutelli apice per suturam usque prope marginem exteriorem curvata (macula axillari nulla), fascia subrecta post medium (apud suturam antice dilatata) apiceque, cinereis; antennis, tibiis tarsisque testaceo-rufis; pectore ventrisque basi albis. Long. 7½ millim.

Yokohama.

CLYTANTHUS XENISCUS, n. sp.

C. gracilipedi quoad signaturas sat similis, sed differt capite (cum oculis) thoracis medio latiori. Angustus, sublinearis, cinerascenti-niger, scutello albo; elytris vittula obliqua longe post scutellum, maculis versus humeros duabus, fascia lata postmediana apiceque, cinereis; sternis ventreque partim albis; antennis et tarsis fulvescentibus; pedibus elongatis, gracilibus; tuberibus antenniferis approximatis sat elevatis. Long. 7½ millim.

Hakodate; Sapporo.

CLYTANTHUS (?) ACUTIVITTIS, *Kraatz, Deutsche ent. Zeitschr.* 1879, p. 111, t. 1. f. 1.

R. Amur. According to Kraatz, taken by Von Hilgendorf also in Japan.

Mr. Lewis's examples form a constant, though slight, variety as follows:—

Var. *C. inscriptus.* Thorax indistincte fusco-trilineatus nec maculatus; elytrorum fasciæ obliquæ apud marginem dilatatæ nec acute antrorsum reflectæ, macula nigra transversa ante apicem.

Chiuzenji and Oyayama; rare.

Kraatz places the species doubtfully in the genus or section *Xylotrechus.* It wants, however, the essential character of carinated centre of forehead peculiar to that generic division of Clytinæ. The long clavate femora and cristated longitudinal ridge of the thorax separate it from *Clytanthus* and bring it near to *Clytosaurus*; it differs from the latter by its long cylindrical thorax, vertical forehead, and other characters, and belongs probably to a distinct group allied to *Clytosaurus.*

DEMONAX TRANSILIS, n. sp.

Antennarum articulo quarto apice intus breviter spinoso. Gracillimus, cinerascenti-niger, thorace anguste elongato-ovato (medio capite cum oculis haud latiori) cinereo-pubescenti maculis

duabus disci nigris; elytris (basi ramulum utrinque ante humerum emittenti) vitta longe post scutellum obliqua (extus recurva et interdum ramulum basis attingenti), fascia lata pone medium (apud suturam antice valde dilatata) apiceque late, cinereis; tuberibus antenniferis conspicue elevatis; oculis prominentibus; elytris apice late flexuoso-truncatis, angulis breviter spinosis; antennis ♂ corpore haud longioribus; pedibus gracilibus. Long. 9–10 millim.

Suyama; Nikko; Yokohama.

The short but distinct spine at the apex of the fourth antennal joint brings this species within the definition of the tropical Asiatic genus *Demonax*; but the spine in *Demonax* is generally of great length and repeated on the third joint.

CLYTUS MELÆNUS, n. sp.

C. rhamni (Linn.) paullo gracilior, nigerrimus, elytris subnitidis, macula humerali, fascia arietina, altera post medium paullulum obliqua, scutelloque albis; sternis singulis ventrisque segmentis 1–3 utrinque macula laterali triangulari alba. Capite, pedibus antennisque fere sicut in *C. rhamni* (sed nigris), thorace longiori, oblongo-ovato multo minus dense punctulato, cum elytris longe sed sparsim griseo-hirto et suberecte breviter nigrosetoso; elytris postice haud attenuatis, apice valde flexuoso-truncatis, angulis breviter spiniferis. Long. 8½–11 millim.

Junsai.

Allied to *C. arietis* and *C. rhamni*, but the thorax more elongate than either, the thorax without coloured margins, and the colour of the whole insect deep black, except the scutellum, elytral markings, and spots on the underside, which are pure white.

CLYTUS AURIPILIS, n. sp.

C. arieti (Linn.) longior thoraceque relative multo magis elongato. Flavo-pilosus, thorace antice maculis 5 nigris (una mediana furcata), duabus utrinque lateralibus linearibus; elytris pilis longis, densis, adpressis, auro-sericeis vestitis, signaturis nigris nudis opacis, viz. annulo ovali utrinque basali, fascia valde obliqua mediana (ad marginem dilatata et retrocurvata), fascia recta ante apicem, marginibusque lateralibus (post fasciam ante-apicalem) dilatata sed apicem haud attingenti. Capite sicut in *C. arieti*, sed erecte piloso; antennis dimidio corporis haud longioribus, sat robustis; thorace elongato anguste ovato, postice magis quam

antice angustato; elytris obtuse truncatis; pedibus nigris, femoribus gradatim incrassatis, posticis elytris multo longioribus. Long. 12 millim. ♂?

Sapporo.

Remarkable for the dense golden-yellow pile of the elytra, which is laid partly transversely and partly longitudinally.

XYLOTRECHUS CHINENSIS, *Chevrolat, Rev. Zool.* 1842, p. 416.

South and Central Japan; also Yezo. China.

"Feeds in the larva state in pollard mulberry-trees, planted for silkworms. In August the imago sits on the upper surface of a leaf or walks about with a jerky gait, after the manner of a hornet, which it also much resembles in colour." (*Lewis.*)

XYLOTRECHUS EMACIATUS, n. sp.

Angustus, sublinearis; fronte subobsolete bicarinata; thorace valde convexo quadrato-ovato, medio haud dilatato nec basi constricto, elytris apice flexuoso-truncatis, angulo exteriori spinoso; pedibus in hoc genere gracilibus. Niger, fronte albo-bifasciata; thorace creberrime confluenter punctulato, linea dorsali cristata, marginibus antico et postico fasciaque mediana, albis; elytris nigris, basi testaceis, fascia parum obliqua subbasali, altera valde obliqua ante medium (ad suturam antice prolongata sed fasciam anteriorem haud attingenti), fascia recta ante apicem, flavis, apice late cinereis; antennis pedibusque piceo-rufis; ventre flavo-annulato. Long. 8 millim. ♀?

Kurigahara.

Not a typical *Xylotrechus*, though better placed here than in *Clytus*, the forehead being rounded and having the rudiments of carinæ, and the thorax, though wanting the characteristic outline of *Xylotrechus*, having a roughened raised dorsal line.

XYLOTRECHUS CLARINUS, n. sp.

X. ibici (Gebler) quam proxime affinis, differt tantum elytrorum sutura inter fascias secundam et tertiam nigra, inter tertiam et apicem flava. Niger, thorace antice et postice flavo marginato, elytris fascia secunda postice sinuata, tertia plerumque per suturam cum fascia apicali conjuncta; antennis pedibusque fulvo-rufis, femoribus nigro-fuscis; corpore subtus griseo-pubescenti, macula apud episterni metathoracis apicem, marginibusque an-

gustis ventris segmentorum, flavis; elytris apice suboblique truncatis, angulo exteriori vix producto. Long. 12–15 millim.

Junsai.

Agrees with *X. ibex* (Gebler) in the points in which it differs from the European *X. antilope*, but differs in there being no trace, in the numerous specimens examined, of yellow sutural margin between the 2nd and 3rd fasciæ of the elytra, but, on the other hand, distinct traces of a similar margin between the 3rd fascia and the yellow apex. The posterior margin of the thorax is yellow, interrupted sometimes in the middle, and sometimes also on each flank, but never forming two distinct subtriangular spots; the yellow spot on the mesothoracic episterna is wanting, as in *X. ibex*, and the 2nd fascia is sinuated behind as in that species; it is also continued anteriorly along the lateral margin, which under the shoulders is testaceous, as is also the base near the scutellum.

Xylotrechus albifilis, n. sp.

X. hirco (Gebler, = *decolor*, Thieme) quoad colores simillimus, sed multo major, valde elongatus, thorace absque lineolis albis etc. Niger, opacus, elytris pallide fuscis vel lividis nitidis, vitta lata marginali bis-interrupta nigra, fasciisque tenuissimis et obliquissimis duabus, guttula subhumerali et macula trigona apicali, cinereo-albis (fascia prima a margine usque prope suturam curvata, deinde usque ad scutellum oblique continuata, secunda post medium a sutura usque ad marginem oblique ducta); fronte medio bicarinata, carinis postice conjunctis et in carinam unicam continuatis, marginibusque acute carinatis; thorace medio parum dilatato, dorso postice convexo aspere rugoso, basi prope angulos utrinque macula cinerea; elytris postice vix angustatis, apice recte truncatis angulo exteriori spinoso, dorso subtilissime punctulato breviter incumbenti-setoso nitido, utrinque obsolete bicostulato; corpore subtus nigro sat nitido, breviter griseo-pubescenti, metathoracis episterno apice macula magna flava, metasterno ventrisque segmentis 1–3 apice interrupte flavo-marginatis. Antennæ (♂) dimidio corporis paullo longiores filiformes; pedes robusti, femora valide incrassata; tarsi postici articulo primo longissimo, 2–4 brevissimis. Long. 16–20 millim.

Junsai: Usui-togé.

Var. Signaturis cinereis paullo latioribus, suturaque a scutello usque fasciam secundam late cinereo marginata. R. Amur.

The peculiar colour and thread-like markings of the elytra are nearly the same as in *X. hircus*, Gebl., with the exception that *X. albifilis* has a large, triangular, grey-white spot at the sutural apex. But the two species differ very greatly in many points of structure: in *X. hircus* the frontal carinæ are divergent behind, and there is no single carina in continuation along the vertex; the antennæ are formed of shorter and rather more triangular joints instead of being filiform; the thorax is very broadly dilated and rounded ("globosus," as Gebler describes it), in *X. albifilis* it is oblong-ovate, and the elytra are rounded at the apices and of less elongated outline in shape.

The Amur specimen, which differs a little in elytral markings from Mr. Lewis's series from Japan, was obtained from the same collection, made on the Amur, which contained examples of *X. hircus*. The species appears not to have been described by any of the numerous writers on East-Siberian Coleoptera.

XYLOTRECHUS RUFILIUS, n. sp.

X. pyrrhodero (Bates) simillimus. Brevior, niger opacus, thorace (margine antico nigro excepto) supra sanguineo, elytris basi, fascia subrecta subbasali (suturaque inter fasciam et scutellum), fascia ante-apicali (vittaque marginali inter fasciam et apicem) cinereis (interdum testaceo-cinereis); subtus nigro, cinereo-pubescenti, metathoracis episternis, apice ventrisque segmentis 1–3 postice densius cinereis; fronte medio sex-carinata; thorace subgloboso, dorso grosse intricato-ruguloso; elytris curvatim modice angustatis, apice subrecte-truncatis angulis acutis, adpresso-pilosis. Antennæ in utroque sexu filiformes nec apice incrassatæ. Long. 9–10 millim. ♂ ♀.

Junsai.

In *X. pyrrhoderus* the middle frontal carinæ are obsolete and undistinguishable, but the lateral carinæ very acute; the antennæ are greatly thickened (excessively so in ♀) after the 4th joint; the thorax finely intricate rugulose-punctate and red beneath as well as above; the elytra have no part of the suture grey, and want the apical lateral grey streak; lastly, the body beneath is differently clothed with grey pile, the middle being shining black, and one fascia only being present across the ventral segment.

XYLOTRECHUS GRAYI, *White*.

Add to the localities formerly recorded, Yezo.

Brachyclytus singularis, *Kraatz, Deutsche ent. Zeitschr.* 1879, p. 107, t. 1. fig. 6.

Between Hakone and Syama, in flowers of *Deutzia*.

Agrees with Kraatz's description, with the unimportant exception that the posterior fascia of the elytra is bright yellow instead of "testaceous" like the anterior band, and that the base of the elytra is not red, but a light purplish brown. The genus is closely allied to *Xylotreckus*, Mr. Lewis's example showing the rudiments of frontal carinæ.

Anaglyptus niponensis, n. sp.

A. gibboso quoad formam similis, sed differt coloribus lætioribus, elytris apice transversim sinuato-truncatis, angulo exteriori longe spinoso, etc. Postice attenuatus, niger, elytris dimidio basali rufo, antice fascia lata utrinque purpureo-nigra cinereo-marginata, a sutura curvatim et oblique versus marginem (quod non attigenti) ducta, medio macula magna communi cinerea; posthac, fascia lata antice bidentata nigra, apice late cæruleo-griseis. Capite et thorace creberrime ruguloso-punctulatis, hoc postice gibboso subcompresso, basi constricto; elytris a basi usque ad apicem recte angustatis, apice transversim sinuato-truncatis, angulo suturali breviter, externo longissime, spinoso, basi rectis humeris subacutis, crista utrinque basali valde elevata, carinula submarginali postice acuta usque ad spinam continuata. Antennæ, articulo tertio sequente duplo longiori, apice intus quam in *A. gibboso* brevius spinoso, articulis 4^{o}–6^{m} apice brevissime spinosis. Long. 7–9 millim.

Miyanoshita; Kiga; Oyayama; Nikko.

Paraclytus, nov. gen.

Gen. *Anaglypto* affine; differt antennarum articulis 3–5 subæqualibus, tertio apice in utroque sexu inermi.

This new generic division is necessary for the reception of a species which differs from *Anaglyptus* and *Cyrtophorus* by the absence of all trace of spine, in either sex, from the 3rd antennal joint. In the style of marking and general form it differs also much from the genera mentioned and all other Clytinæ. *Clytus caucasicus*, Motschulsky, referred by modern writers to the genus *Anaglyptus* or to *Cyrtophorus*, belongs to *Paraclytus*.

Paraclytus excultus, n. sp. (Plate I. fig. 11.)

Elongatus, linearis, niger, cano vel griseo tomentosus, thorace

supra plagis duabus (interdum in 4 divisis) nigris, elytris nigris margine laterali et medio basis testaceis; vittula curta obliqua ab humero versus discum, vitta valde obliqua a sutura usque marginem, ante medium, macula transversa mediana juxta suturam, fascia recta ante apicem, sutura a scutello usque ad hanc fasciam et apice late, cinereis (fasciis etc. prope basin plus minusve testaceis); antennis (corpore longioribus) pedibusque nigris, subtiliter griseo-pubescentibus; thorace subcylindrico, medio utrinque subangulato basi constricto; elytris apice declivibus juxta suturam breviter sinuato-truncatis, angulo exteriori modice producto, cristis basalibus obtusis parum elevatis, humeris vix rectis. Long. 11–15 millim.

Sparingly throughout Japan.

The white markings and the clothing of the underside consist in fine and compact adpressed pile; the head and margins of pronotum have a similar but rather coarser pile. The rich deep black parts of the elytra have a black pile, generally partly abraded, and exposing a close and strong punctuation of the integument.

Aglaophis colobotheoides, n. sp. (Plate I. fig. 12.)

Facies gen. *Colobotheæ*. Nigra, antennis articulis (a secundo) basi griseo-rufis, femoribus pedunculo rufo, elytris ultra medium fascia recta lata (marginibus dentatis) nigra, apice late cinereis, cætera superficie rufo-castaneo nigro varia, fasciis irregularibus undulatis et intermixtis cinereis; capite griseo-hirto; thorace fere sicut in *Anaglypto mystico*, sed magis convexo, creberrime alveolato-punctato; elytris lineari-oblongis, versus apicem attenuatis apice anguste sinuato-truncatis angulo externo longe et acute producto, lateribus altis et verticalibus, prope humeros prominentes subcarinatis; pedibus sicut in *A. mystico*, femoribus abruptius clavatis. Long. 14 millim. ♀ ?

Sapporo.

The head and thorax are nearly the same as in *Anaglyptus mysticus* (Linn.), but the elytra more nearly approach, in form and colours, certain species of *Colobothea*. I refer the species to the Indian genus *Aglaophis*, notwithstanding the absence of the peculiar double convexity of the thorax in that genus, this character being distinctly pronounced, judging from an undescribed species which I have examined, in the ♂ only. The third joint of the antennæ is much longer than the fourth and unarmed, the

lateral carina of the elytra near the angular shoulder is not sharply pronounced as in the typical *Aglaophis*, but obtuse; the basal crests are elevated, compressed, and clothed with black hairs.

PURPURICENUS SPECTABILIS, *Motsch.*

Syn. *P. nigrohirtus*, Lewis.

Kobe, north to Sapporo.

Fam. LAMIIDÆ.

PHLYCTIDOLA, nov. gen.

Gen. *Deucalioni* et *Dorcadidæ* affine: differt thoracis spina laterali plurituberculata etc. Elongato-ovata, convexa, subglabra; caput inter antennas latum, parum concavum. Palpi articulo terminali breviter ovato acuminato. Antennæ corpore longiores, scapo sicut in *Deucalioni* oblongo-clavato, articulo tertio cæteris multo longiori, sed haud crassiori, 4°–11^{m} gradatim parum decrescentibus. Thorax quadratus, medio angulatim dilatatus ibique plurituberculatus, tuberculo centrali (in loco spinæ) majori. Elytra regulariter convexa, apice obtusa. Acetabula antica extus late angulata; intermedia aperta. Ventris processus intercoxalis latus, ogivalis. Tibiæ intermediæ medio extus vix tuberculatæ sulcisque haud conspicuis.

The species on which this genus is founded is most nearly allied to the rare Madeiran genus *Deucalion*, the only structural features which distinguish it from that form being the widely gaping anterior haunch-sockets and the nearly simple outer edge of the intermediate tibiæ. In general form, however, the species much more nearly resembles *Parmena*, from which it differs in the absence of long pubescence, the rather longer and more oblong scape (much shorter and thicker than in *Dorcadida*), and the broad ogival intercoxal process.

PHLYCTIDOLA METALLICA, n. sp. (Plate I. fig. 2.)

Cupreo- vel æneo-fusca, subnuda parum nitida, pilis fulvis curtis adpressis supra elytra maculatim vestita; scutello dense fulvo-pubescenti; capite et thorace grosse intricato-rugosis, hoc plagis 2–3 parvis elevatis politis; elytris sat grosse punctatis subrugosis, utrinque costis obtusis sæpe interruptis nitidis tribus. Long. 10–11 millim.

Sapporo; Nikko; Oyayama.

Echthistatus binodosus, *Waterhouse*, *Trans. Ent. Soc.* 1881, p. 431.

Occurs from Chiuzenji north to Awomori, and also on the island of Sado, on beech-trees. Commonest in September.

Echthistatus furciferus, n. sp.

E. gibbero (Bates) similis, sed differt elytris tuberculis parvis rotundatis nigro-nitidis conspersis, una utrinque prope scutellum multo majori. Ochraceo-fuscus, antennis pedibusque piceo-rufis, elytris sicut in *E. gibbero*, epipleuris altis verticalibus carinaque flexuosa a dorso separatis; postice subito declivibus sed declivitate multo longiori apiceque longius divergenti-spinoso. Long. 15 millim. ♂.

Hiogo, on Maigasan.

Echthistatus grossus, n. sp.

E. gibbero proxime affinis et forsan ejus varietas; differt elytris a basi paullo dilatatis, gibbere altiori et latiori, spinis apicalibus latioribus minusque acuminatis; colore obscuriori, nigro-fusco. Long. 16 millim. ♂.

Yuyama, in damp forests in May.

In *E. gibber* the elytra are broadest at the shoulders, but in *E. grossus* at the end of the gibbosity, where the tuberculated lateral carina curves round towards the disk. The small tubercles at the base of the elytra, on each side of the scutellum, are much more numerous, about twelve, and larger, forming a linear crest.

The genus *Echthistatus* seems to me to belong to the true *Lamiinæ*, and not to the *Dorcadioninæ*, where Lacordaire placed it, trusting too much to the shortness of the metasternum, which led him to introduce numerous forms into the *Dorcadioninæ* subfamily which have their true affinities elsewhere. The cicatrized tip of the scape, one of the chief characteristics of the *Lamiinæ*, is strongly marked in *E. gibber* and *E. grossus*, more feebly so in *E. binodosus*, and only just perceptible in *E. furciferus*.

Dolophrades, nov. gen.

Gen. incertæ sedis *Monohammis* minoribus haud dissimile. Parvus, anguste elongato-ovatus. Caput sicut in *Dorcadida*, vertice integro vix concavo, post oculos haud impresso. Palpi articulis apicalibus ovatis, breviter truncatis. Antennæ (♂) fere sicut in *Monohammo fraudatori* (Bates), corporis dimidio lon-

giores, articulis 3–4 cæteris paullo crassioribus; scapo subcylindrico, apice anguste cicatricoso et carinulato. Thorax quadratus, spina laterali retrorsum paullo curvata. Elytra a medio gradatim angustata, humeris subrectis, apice rotundata, supra parum convexa, postice sensim declivia, grosse sublineatim punctata. Pedes sicut in *Monohammis*, tibiæ intermediæ infra medium tuberculatæ. Pro- et mesosterna arcuata; metasternum paullo abbreviatum. Acetabula antica extus angulata, intermedia aperta.

Founded on a small species partaking of the characters of the two subfamilies *Dorcadioninæ* and *Lamiinæ*. The head and thorax are, relatively to the rest of the body, long, and resemble much those of *Dorcadida*, *Deucalion*, and allies; the thoracic spines, though much smaller, are similar in position to those of *Lepromoris*.

DOLOPHRADES TERRENUS, n. sp. (Plate I. fig. 10.)

Fulvescenti-fuscus, subsericeo-tomentosus; scutello ochreo-pubescenti; antennarum articulis 4–11 basi obscure griseis; capite et thorace passim discrete punctulatis, hoc supra inæquali; elytris grossius, hic illic seriatim, punctatis, interstitiis subrugulosis. Long. 10 millim. ♂.

Hitoyoshi.

MONOHAMMUS NITENS, n. sp.

M. sutori etc. affinis, sed differt elytris æneo-nigris politis albo-maculatis. Elongatus, ♂ postice vix angustatus, æneo-niger politus subtus griseo-pubescens, supra maculis albis (raro ochraceo-albis) parvis irregularibus passim conspersis, apud elytras hic illic in maculas majores confluentibus; antennis nigris concoloribus; thorace antice et postice ruguloso, disco variabili, sparse punctulato, vel scabroso, interdum sublævigato; spina laterali valida; elytris erecte setosis, subtiliter punctato-rugulosis interdum fere lævibus, versus basin granulato-punctatis. Long. 22–27 millim. ♂ ♀.

Niohozan, middle of August, on *Abies* newly felled.

MONOHAMMUS LUXURIOSUS, *Bates*.

Yezo.

MONOHAMMUS GRANDIS, *Waterh. Trans. Ent. Soc.* 1881, p. 431.

Yezo. Chiuzenji and Sapporo, taken flying in August; dug out of *Abies* on Tsukuba-yama in June.

MONOHAMMUS PARDALINUS, n. sp.

Pro hoc genere parvus et gracilis; antennis tenuibus, articulis 3–5 subtus sparse ciliatis tibiisque intermediis medio extus haud tuberculatis. Elongatus, fuscus, supra pallidus vel fulvo-fuscus, maculis numerosissimis rotundatis atro-fuscis, plerumque separatis conspersis, post medium in maculam utrinque majorem congestis. Capite et oculis sicut in *Monohammis* typicis, sed tuberibus antenniferis apice haud acutis; antennis (♂) corpore plusquam duplo longioribus, obscure rufis, articulis a tertio basi griseo-testaceis; thoracis spinis lateralibus conicis acutis; elytris relative valde elongatis, post medium paullulum ampliatis deinde usque ad apicem curvatim angustatis, apice singulatim rotundatis. Long. 12 millim. ♂.

Yuyama.

The slender antennæ and the markings give this species the appearance of an elongate *Leiopus*; but the perfectly margined cicatrice and the shape of the scape, the thorax, and other characters are those of *Monohammus*. The slightly rounded sides of the elytra are seen in several small species of true *Monohammus* from Assam and Siam, and the scantily ciliated basal joints of the antennæ it partakes with *M. Fredericus* (White). The only character which may be of generic importance is the total absence of tubercle and notch preceding the sinuation of the middle tibiæ.

HAPLOHAMMUS, nov. gen.

A *Monohammo* differt scapi cicatrice læviori, minus acute et integriter marginato. A *Dihammo* (Thoms.) differt tibiis et tarsis anticis ♂ normalibus.

A genus proposed for a numerous series of Indo-Malayan and Australasian *Monohammi* which differ from the typical species by the smoother antennal scape and the less abruptly truncated and smoother cicatrice, the bordering rim of which is much less complete. The series of species is readily distinguishable from the true *Monohammi* by their more uniform colours and "facies." *Dihammus*, Thoms., an equally numerous Eastern group, presents a similar form of cicatrice, but is amply distinguished by the prolonged external apices of joints 1 and 2 of the anterior tarsi of the male, and the dentiform projection which surmounts the groove of the anterior tibiæ in the same sex.

The following Japanese species belong to the genus:—*H. luxuriosus*, *H. fraudator*, *H. sejunctus*, and *H. degener**.

HAPLOHAMMUS FULVICORNIS, *Pascoe, Ann. & Mag. Nat. Hist.* ser. 4, xv. p. 64.

Japan (*Whitely*). Hakodate (?).

Mr. Lewis considers this as belonging either to *M. sejunctus* or *M. fraudator* (Bates). I have seen no specimens which exactly agree with Pascoe's description of the antennæ.

URÆCHA GRISEOLA, n. sp.

Elongata, angusta, fusca, antennis (scapo fusco excepto) pedibusque fulvescenti-rufis, elytris apice obtuse rotundatis, griseis, fusco maculatis, vitta mediana valde obliqua, maculaque irregulari submarginali, fuscis; thorace et elytris quam in *U. bimaculata* grossius punctatis; spina laterali thoracica angusta, acutissima paullulum hamata. Long. 9 millim. ♂.

Kashiwagi.

Of similar elongate sublinear form to the type species *U. bimaculata*; the antennæ also proportionately long, more than twice the length of the body. From *Uræcha* (*Monohammus*) *angusta*, Pascoe, with which it agrees in the obtuse apices of the elytra, it differs in markings, and especially in the finer and longer thoracic spines.

URÆCHA BIMACULATA, *Thomson*.

South and Central Japan; also Yezo.

MECYNIPPUS, nov. gen.

Gen. *Goes* (Leconte) simillimus, *Thesto* (Pascoe) affinis. Maxime elongatus, sublinearis. Caput sicut in *Monohammis* veris, oculis infra paullo latius quadratis; palpi tenues, apice acuminati. Antennæ (♂ ♀) corpore paullo longiores; scapo brevi, oblongo-conico, cicatrice lata grosse scabrosa integriter

* *Haplohammus* is closely allied to *Orsidis*, Pascoe, and I have hesitated to separate it; the form of the scape and its cicatrice is nearly the same in both, but *Orsidis*, at least the type species *O. oppositus*, differs from all the *Haplohammi* in the larger and broader lower lobe of the eyes and shorter forehead, characters which, being supported by some difference in the form of body and thoracic spines, may justify the severance of the two genera. Some of Pascoe's *Orsidis*, e. g. *O. sobrius*, are possibly true *Haplohammi*; *O. sobrius* is probably closely allied to the *Mon. fulvicornis* of the same author.

marginata, articulis 3–5 subtus densissime ciliatis. Thorax relative brevis, spina laterali longissima, recta, acuta. Elytra relative longissima, apice breviter truncata, humeris rectis, subtiliter parce sublineatim punctulata, versus basin minute granulata, obsolete pluricostulata. Sterna normalia inermia. Tibiæ intermediæ extus tuberculo mediano acuto subspiniformi.

In the dense hair-fringe beneath the antennal joints 3–5 this genus resembles *Thestus*, from which it differs in the long thoracic spine, plane mesosternum, and other characters. The resemblance and real affinity to the North-American genus *Goes* is not less striking. The short antennal scape, about one third the length of the third joint, and the long and acute tubercle of the middle tibiæ are features peculiar to the genus.

Mecynippus pubicornis, n. sp. (Plate II. fig. 12.)

Maxime elongatus, pallide fuscus, antennis pedibusque testaceo-rufis; fulvo-tomentosus et brevissime erecte setosus, fusco-conspersus, fascia elytrorum mediana obliqua cinerea (interdum subobsoleta) et, pone hanc, fascia vel macula magna triangulari obscure fusca; supra toto sparsim punctulatus, punctulis versus elytrorum basin granulatis, versus apicem obsoletis, lineis longitudinalibus indistinctis elevatis; apice juxta suturam breviter sinuato-truncatis. Long. 20–26 millim.

Sapporo.

Apalimna, nov. gen.

Gen. *Palimnæ* (Pascoe) affinissimum; differt tantum thorace utrinque tuberculo valido conico, antennisque articulo septimo (ut cæteris) simplici. Frons infra paullo dilatata.

The species on which this genus is founded resembles the *Palimnæ* in colour and markings, but differs in the thorax having large conical lateral tubercles. Its real affinity to the *Palimnæ* is shown in the form of the cicatrice of the scape—very large and coarsely scabrous, and limited by a carina only for one half its contour; and also in the long middle tibiæ, on which the tubercle and groove lie nearly at the apex. The species wants the spinose centro-basal crests of the elytra, but these are not constant in *Palimna*, an undescribed species from the Andaman Islands exhibiting them in a very rudimentary condition.

APALIMNA LITURATA, n. sp.* (Plate II. fig. 5.)

Oblonga, cinereo-albo tomentosa, antennis et pedibus nigro-annulatis, capite postice, maculis septem, thorace vittis quatuor (2 medianis interruptis) elytrisque maculis numerosis plerumque undulatis, nigris; elytris oblongis, passim sparse punctatis, prope apicem angustatis, apice singulatim acuminatis vel brevissime oblique truncatis, tuberibus centro-basalibus obtusis paullo elevatis. Long. 18 millim.

All the islands, in beech-forests.

XENICOTELA, nov. gen.

Gen. *Xenoleæ* (Thoms.) simillima, sed differt antennarum scapo apice anguste cicatricoso, lævi, acute et integriter marginato. Parva, subcylindrica. Caput exsertum; tubera antennifera elevata, divergentia; frons quadrata plana; oculi grosse granulati. Antennæ corpore duplo longiores, apicem versus tenuiores, scapo brevi, oblongo-clavato, cicatrice angustissima acute marginato, lævi; articulo 3° elongato, robusto, cæteris gradatim brevioribus. Thorax cylindricus, tuberculo mediano valido, conico. Elytra cylindrica, æqualia, apice conjunctim rotundata. Pedes sat breves et tenues, tibiis anterioribus flexuosis, intermediis simplicibus. Acetabula antica extus angulata, intermedia clausa.

Founded on a small species resembling much *Xenolea*, but differing from that genus and its allies (*Dorcaschema*, *Hetæmis*, &c.) in the scape being smooth, with the cicatrice narrow and sharply margined, instead of very large, oblique, and scabrous, as in the genera just named.

XENICOTELA FUSCULA, n. sp. (Plate II. fig. 2.)

Olivaceo-fusca, adpresso-pubescens, antennis et tarsis fulvo-

* A second and much finer species of *Apalimna* occurs in Northern India. It is relatively much broader and more robust, with elytra more triangular in outline and furnished with strongly bituberculated centro-basal crests. The other characters are as in *A. liturata*.—APALIMNA DUCALIS, n. sp. Lata, robusta, cinereo-albo tomentosa (prope scutellum et humeros fulva), antennis et pedibus nigro-annulatis, capite antice et occipite thoracisque disco maculatis, elytris fascia obliqua post medium maculisque suturalibus et apicalibus, nigris: thorace disco trituberculato, scutello bicornuto, elytris apice conjunctim rotundatis, basi latis, humeris tuberculatis antice productis, crista utrinque centro-basalis valde bituberculatis, pone scutellum et humeros grossissime punctatis, carinaque discoidali flexuosa. Long. 20–24 millim. ♂ ♀. North India (*Buckley*).

testaceis, illarum articulis a tertio basi pallidis, capite et thorace sparsim punctulatis, elytris paullo grossius sublineatim punctulatis, interstitiis subrugulosis, atro-fusco maculatis, maculisque utrinque tribus irregularibus majoribus (subbasali, mediana et subapicali). Long. 7 millim. ♂.

Higo.

Rhodopis integripennis, n. sp.

R. Lewisii (Bates) affinis. Elongatus, rufescenti-fuscus, fulvo-ochraceo adpresso-pubescens; antennis testaceo-rufis, clava (♂) nigra, polita, articulis 4–11 apice fuscis; elytris apice conjunctim rotundatis, fusco-guttatis, utrinque macula angulari pone medium versus marginem nigra; pedibus piceis, femoribus tibiisque basi testaceo-rufis: supra totus punctulatus, elytris paullo grossius punctatis. Long. 12 millim. ♂.

Wada-togé.

Differs from the other described species of this well-marked genus in the perfectly rounded apices of the elytra.

Rhodopis Lewisii, *Bates*.

Hiogo; Yezo.

Nanohammus, nov. gen.

Gen. *Olenocampto* et *Xenoleæ* affinis; differt tibiis intermediis simplicibus. Parvus, cylindricus, subglaber. Caput exsertum, occipite lato et convexo; fronte brevi, quadrata, vertice inter antennas concava, post oculos haud transverse impressa. Oculi angusti, grosse granulati, lobis inferioribus infra subacuminatis. Palpi elongati, articulo terminali præcedenti duplo longiori. Antennæ (♀?) corpore parum longiores, subnudæ; scapo gracili oblongo-conico, apice extus obsolete late cicatricoso, ex parte subtilissime marginato; articulo tertio quam scapus tertia parte longiori, quam art. quartus paullo longiori, cæteris gradatim decrescentibus. Thorax breviter cylindricus, antice et postice leviter constrictus, tuberculo laterali mediano, acutissimo. Elytra cylindrica, æqualia, crebre punctata, apice rotundata. Sterna simpliciter arcuata; acetabula antica extus late angulata; intermedia aperta. Pedes modice elongati; tibiæ intermediæ graciles, lineares, extus omnino integræ. Tarsi sat breves et lati; ungues divaricati.

In facies resembling *Monohammus*, though of diminutive size. Differs from that genus and from *Olenocamptus* and allies, to

which it is more nearly allied, in the perfectly straight outer edge of the intermediate tibiæ. The cicatrice of the scape is visible only in a certain light, and recognizable chiefly by its limiting margin; it is very broad, as in *Xenolea*.

NANOHAMMUS RUFESCENS, n. sp. (Plate II. fig. 4.)

Fulvo-castaneus, subnudus, thoracis linea dorsali, scutello maculisque elytrorum (ante et post medium subfasciatim congregatis) ochraceo-tomentosis; antennarum articulis 3–4 basi tibiisque pallidioribus; capite omnino discrete punctulato; thorace creberrime subconfluenter, elytris passim discrete hic illic seriatim, punctatis. Long. 7 millim.

Chiuzenji.

SCOTINAUGES DIPHYSIS, *Pascoe, Ann. & Mag. N. H.* 1871, p. 277, t. xiii. fig. 4.

Island of Tsu-shima (*Bowring*).

This species was omitted from my first enumeration of the Longicornia of Japan.

MESOSA GRACILIOR, n. sp.

M. nebulosæ (Oliv.) primo intuitu similis, sed angustior, gracilis, thorace præcipue angustiori, minori lateribusque rotundatis. Anguste oblonga, fulvescenti-fusco adpresso-pubescens, vertice et thorace nigro pluri-maculatis (nec vittatis); elytris guttis sat confertis nigris fasciaque mediana dentata cinerea nigro partim marginata; antennis nigro-fuscis, articulis basi griseis; elytris elongato-oblongis, crebrius quam in *M. nebulosa* punctulatis. Long. 10–11 millim. ♂ ♀.

Oyayama.

Narrower and more elongated than *M. nebulosa*, the thorax especially relatively much smaller and narrower and rounded on the sides.

MESOSA JAPONICA, *Bates*.

S. Japan; also Yezo.

MESOSA HIRSUTA, n. sp.

Elongato-oblonga, supra dense erecte pubescens, fusco-tomentosa, griseo plagiatim varia; thoracis maculis novem (interdum indistinctis), elytrorum maculis circa 20, quarum 4 suturalibus communibus, atro-fuscis; antennis fusco-nigris, articulis 3–11

basi griseis, scapo griseo et fusco-piperito, art. undecimo præcedenti ♂ paullo, ♀ dimidio, breviori; thorace vix inæquali, lateribus leviter rotundatis, sparsim punctulato; elytris subtilius quam in *M. nebulosa* punctulatis; pedibus griseis nigro-annulatis sicut in *M. nebulosa.* Long. 12–16 millim. ♂ ♀.

Kobé.

Mesosa senilis, n. sp.

M. nebulosæ quoad formam similis, sed paullo magis elongata, canescenti-griseo tomentosa, thoracis vittis duabus angustis (sæpe obsoletis), elytrorum vitta curvata subhumerali, macula longe post medium marginali maculisque suturalibus discoidalibusque (sæpe deficientibus) nigris. Antennis griseis, articulis 3–10 apice breviter infuscatis, ♂ corpore dimidio longioribus, articulo undecimo ♂ elongato precedenti sublongiori, ♀ præcedenti breviori; thorace sicut in *M. nebulosa* inæquali; scutello toto griseo; elytris sparsim punctatis, punctis nigris. Long. 11–12 millim. ♂ ♀.

Junsai; Oyama; Sapporo.

Varies much in the number and distinctness of the black spots and marks; the hoary laid pubescence is sometimes thin and coarse, and then seems to cover the black marks. In some examples the prevailing colour is light brownish-grey instead of light grey.

Mesosa pœcila, n. sp.

Elongato-oblonga, erecte nigro-pubescens, griseo- vel ochraceogriseo tomentosa tota nigro-piperita, fascia undulata elytrorum longe post medium (suturam haud attingenti) maculisque 2–3 marginalibus prope humerum, nigris. Capite inter antennas profundius quam in *M. nebulosa* concavo; thorace relative parvo, juxta basin angustato, dorso haud tuberculato sed antice transversim depresso; scutello griseo, lateribus nigris; elytris punctulatis; antennis griseis, articulis omnibus apice nigris, ♀ (?) art. undecimo precedenti dimidio breviori; pedibus griseis nigromaculatis. Long. 13–17 millim.

Nikko; Junsai.

Mesosa cribrata, n. sp.

Parva, oblonga, erecte pilosa, griseo-fusca tomentosa, elytrorum fasciis duabus latis (altera recta basali, altera post mediana undulata) atrofuscis. Capite inter antennas parum concavo; thorace brevi cylindrico, supra æquali, sparsim grosse punctato;

elytris grosse (versus basin crebre) punctatis; antennis atro-fuscis, articulis 3–11 basi griseis, articulo undecimo (♀?) precedenti duplo minori; pedibus nigro-fuscis griseo variis. Long. 7 millim.

Sapporo.

MESOSELLA, n. gen.

Gen. *Mesosæ* similis, sed differt antennarum scapo apice integro unguibusque subparallelis; subfam. *Niphoninæ* pertinet. Caput inter antennas triangulariter concavum, tuberibus antenniferis apice haud prominentibus. Oculi modice emarginati. Antennæ corpore fere dimidio longiores, scapo quam art. tertius multo breviori, gradatim clavato, nullomodo triquetro, creberrime punctulato, apice extus lævi, polito; art. tertio sat elongato (cum quarto et quinto) subtus ciliato, quarto paullo breviori, cæteribus gradatim decrescentibus. Thorax brevis, subcylindricus, supra æqualis. Elytra oblongo-ovata, absque cristis et tuberculis. Tibiæ intermediæ extus integræ. Tarsi articulo unguiculari elongato, parum robusto.

According to Lacordaire's classification, this genus belongs to the group or subfamily *Niphoninæ*. The species on which it is founded has, however, the closest resemblance to the *Mesosæ*, and might well be taken for *M. gracilior*. The absence of cicatrice from the scape, though its place is indicated by a smooth polished area in the else closely punctured surface, is the chief distinguishing character. The subparallel or "divergent" claws are a less conclusive mark of distinction between the two groups *Mesosinæ* and *Niphoninæ*, many species of the former having claws tending towards the "divergent" position.

MESOSELLA SIMIOLA, n. sp. (Plate II. fig. 3.)

Oblongo-subovata, obscure fusca, fulvo-fusco tomentosa, nigro maculatim varia, elytris fascia post medium dentata (suturam haud attingenti) cinereo-alba; antennarum articulis 3–11 dimidio basali testaceo; pedibus nigris griseo parce maculatis, unguibus fulvis. Long. 8 millim.

Nikko.

Resembles *Mesosa gracilior* and *Praonetha leiopodina*, and intermediate in form between the two species.

SYBRA SUBFASCIATA, n. sp.

Elongata, postice sat convexa; elytris apice singulatim rotun-

datis subangulatis; ochraceo-fusca, atro-fusco (præcipue pone medium) maculata, scutello fasciaque post-mediana (nec latera nec suturam attingenti) cinereis; antennis piceo-rufis, articulis 3–11 basi pallidis; thorace cylindrico, basi paullo angustato, crebre punctulato; elytris crebre, apicem versus subseriatim (ibique interstitiis subelevatis) punctulatis. Long. 11 millim.

Higo.

An elongated species, with the elytra rather rounded from behind the middle to the apex, the latter singly triangularly produced, but not toothed or spined. The coloration is the same as that of *Mesosa gracilior*, *Mesosella simiola*, and *Praonetha leiopodina*.

XYLARIOPSIS, nov. gen.

Gen. *Atimuræ* affinis. Corpus elongato-subcylindricum, postice angustatum, tuberculatum. Caput inter antennas vix concavum, tuberibus antenniferis parum elevatis obtusis, fronte brevi, quadrata, oculis modice emarginatis, grosse granulatis. Antennæ quam corpus vix breviores, subtus ciliatæ; scapo oblongo, articulo tertio quam scapus parum longiori et articulo quarto subæquali, 5–11 gradatim sed parum decrescentibus. Thorax cylindricus, plurituberculatus. Elytra basi thorace multo latiora, versus apicem angustata, apice depressa et producta, apice ipso truncata, dorso subseriatim tuberculata. Pedes breves, robusti; femora clavata; tibiæ intermediæ extus profunde sinuatæ.

XYLARIOPSIS MIMICA, n. sp. (Plate II. fig. 7.)

Breviter sparsim setosa: capite fulvo et fusco tomentoso, occipite bipenicillato; thorace cano-tomentoso, margine basali fusco-maculato; scutello ochraceo linea mediana impressa; elytris fusco-nigro tomentosis, fascia lata antice obliquata paullo ante apicem albo-cinerea; antennis testaceo-fulvis; pedibus cano-tomentosis fusco-variis, tarsis rufescentibus. Long. 12 millim.

Chiuzenji; Sapporo.

SYDONIA DIVARICATA, n. sp.

Sublinearis, fusca, griseo adpresso-pubescens, thorace utrinque griseo-bivittato; elytris vitta discoidali arcuata indistincta subnuda lineolaque grisea utrinque post medium. Capite et thorace subcrebre punctulatis (hoc cylindrico); elytris versus apicem angustatis, apice utrinque oblique truncatis angulisque exterioribus productis divaricatis, supra apice excepto crebre punctatis,

dorso medio longitudinaliter paullo elevato, versus suturam postice depresso tuberibus centrobasalibus obtusis; antennis et pedibus fusco-rufis, illarum articulis a tertio basi cinereis, tibiis apice tarsisque nigris. Long. 7 millim.

Higo; Yuyama.

Belongs to Lacordaire's group *Estolides*, and agrees with the genus *Sydonia* (founded on a species from Singapore) in its cylindrical unarmed thorax and the shortness of the third antennal joint (shorter than the fourth). The form of the apices of the elytra appears also not to be very different from that of the typical species. The obtuse raised line down the middle of the elytra continues to the produced outer angle of the apical truncature, increasing in elevation.

Graphidessa, nov. gen.

Gen. *Tetroreæ* (White) affinis et similis, sed differt antennarum scapo gracilius oblongo nec basi subito constricto. Corpus sublineare, sparsim setosum, postice angustatum. Caput exsertum, inter antennas concavum, fronte brevi; oculi grosse granulati, lobis inferioribus magnis, latis: tubera antennifera supra divaricata sat elevata. Antennæ corpore paullo longiores, infra longe sed sparsim ciliatæ, scapo oblongo-subconico, articulo tertio quam quartus, breviori, 5–9 paullulum, 10–11 multo, brevioribus. Thorax sat elongatus, subcylindricus, dorso inæquali et bituberculato, tuberculo laterali conico, valido, mediano. Elytra anguste oblonga, versus apicem angustata, apice oblique truncata, dorso anteriori depresso, carinula utrinque obtusa centro-basali, penicilla parva sed alta cristata. Sterna inter coxas subplana; acetabula antica extus hiantia, intermedia clausa. Pedes modice elongata; femora clavata; tibiæ intermediæ extus prope medium sinuatæ, et usque ad apicem hirsutæ.

Belongs to the group *Estolides*, and in form and markings resembles the New-Zealand genus *Tetrorea*, from which it differs in the more oblong, less clavate scape, the relatively shorter third joint, and the scantier pilosity of the antennæ, as also in the less strongly clavate femora.

Graphidessa venata, n. sp.

Parva, rufescens, capite thoraceque impunctatis, lituris griseo-sericeis, elytris utrinque versus apicem lineis subtilibus nonnullis confluentibus maculisque griseo-albis; sparsim nigro-setosa,

elytris crebre punctulatis versus apicem sublævibus; tibiis apice nigris. Long. 6½ millim.

Higo.

EUPOGONIUS TENUICORNIS, n. sp.

Subcylindricus, nigro-fuscus, tomento ochraceo-fusco submaculatim vestitus, elytris erecte pilosis, antennis et tarsis fulvo-testaceis, scapo obscuriori; capite inter antennas concavo; thorace cylindrico, punctato, dorso paullo inæquali, tuberculo laterali mediano parvo acuto; elytris linearibus, apice rotundatis sat confertim punctulatis. Long. 5 millim.

Nishimura; Kashiwagi.

Agrees with *Eupogonius* in every respect, except the more elongate antennæ, which are one third longer than the body, and the joints of which, from the fifth to the eleventh, are rather long and slender instead of being much abbreviated. The proportions of the joints and the form of the scape, however, are the same. The form of head and eyes is the same; the middle tibiæ simple, the anterior and middle acetabula open.

TERINÆA, n. gen.

Gen. *Eupogonio* subsimilis, sed tibiis intermediis extus conspicue sinuatis, thoracis spina parva laterali acuta. Corpus sublineare, sparsim adpresso-pubescens et erecte pilosum. Caput exsertum, inter antennas planum; tubera antennifera perparum elevata; frons convexa brevissima; oculi grosse granulati, magni, lobis inferioribus latis convexis. Antennæ filiformes robustæ, infra ciliatæ, corpore multo longiores; scapo oblongo-conico, articulis 3–11 longitudine æqualibus nec scapo longioribus. Thorax breviter cylindricus, medio latior, spina postmediana parva acuta. Elytra subcylindrica, apice obtuse rotundata. Pro- et mesosterna inter coxas subplana, illo sat lato; acetabula antica extus hiantia, intermedia aperta. Pedes breves, femora gradatim incrassata; tibiæ intermediæ extus medio sat profunde sinuatæ nec longe hirsutæ; tarsi omnes breves, unguibus divaricatis.

Fits by its structural characters none of the numerous "groupes" of Lacordaire's classification; but is evidently closely allied to the *Apodasyides*, in which it may be placed if we admit exceptions to the character of simple middle tibiæ distinctive of that group.

TERINÆA ATROFUSCA, n. sp. (Pl. II. fig. 6.)

Nigro-fusca, fulvo-fusco tenuiter pubescens et pilosa, antennis (scapo excepto) pedibusque piceo-fulvis: supra toto confertim punctulata. Long. 6 millim.

Junsai.

Resembles closely in form and colours *Eupogonius tenuicornis*.

CYLINDILLA, nov. gen.

Gen. *Terinææ* affinis, sed differt thorace inermi, tarsorumque articulo unguiculari longiori et robustiori. Corpus parvum angustum, cylindricum, maculatim tomentosum, haud pilosum. Caput exsertum, inter antennas subconcavum, latum; tubera antennifera perparum elevata; frons convexa, brevis; oculi grosse granulati, lobis inferioribus minoribus, latis. Antennæ corpore longiores, filiformes, infra ciliatæ; scapus oblongo-conicus, articulo quarto longitudine scapo æquali, cæteris omnibus paullo brevioribus inter se subæqualibus. Thorax cylindricus, medio paullo rotundatus ibique transversim convexus. Pro- et mesosterna lata, plana. Acetabula antica extus hiantia, intermedia aperta. Pedes breves; tibiæ intermediæ extus sat profunde sinuatæ, hirsutæ; tarsi sat robusti, articulis latis, unguiculari elongato, unguibus divaricatis.

Undoubtedly closely allied to *Terinæa*, and, like that genus, of somewhat doubtful position. The claw-joint of the tarsi is not short and slender at the base as in *Terinæa*, but elongated, almost as in the *Apomecyninæ*, with which the new genus agrees except in the important character of the divaricate claws. The only species known is small and nearly cylindrical.

CYLINDILLA GRISESCENS, n. sp.

Fusca, pube adpressa ochraceo-grisea et grisea maculatim vestita, apice macula majori vel fascia lata albo-grisea; antennis piceo-rufis, articulis 3–11 basi albis: supra sat confertim, apicem versus sparsius et subseriatim, punctata. Long. 5½ millim.

Suyama.

RHOPALOSCELIS UNIFASCIATUS, *Blessig*, *Hor. Soc. Ent. Ross.* ix. p. 206, t. 8. f. 3.

Junsai; Sapporo; Hitoyoshi. Also East Siberia.

Mr. Lewis's specimens do not differ from East-Siberian examples with which I have compared them.

RHOPALOSCELIS MACULATUS, *Bates, Ent. Month. Mag.* xiv. (1877) p. 38.
Junsai; Nikko.

RHOPALOSCELIS BIFASCIATUS, *Kraatz, Deutsche ent. Zeit.* 1879, p. 113, t. 1. fig. 10.
Sapporo; Junsai. Also East Siberia.

ERYSSAMENA, nov. gen.

Gen. *Polimetæ* (Pascoe), necnon *Rhopaloscelidi* (Blessig), affinis. Corpus valde elongatum, parum convexum, subtiliter adpresso-pubescens, erecte setosum. Caput exsertum, inter antennas profunde sulcatum; tubera antennifera separata, divergentia sat elevata; frons lata et brevis: oculi grosse granulati, lobis inferioribus latis. Antennæ elongatæ, filiformes, infra ciliatæ; scapus oblongo-conicus quam articulus 3 brevior, 3 et 4 elongatis subæqualibus, 5–11 gradatim brevioribus. Thorax cylindricus, basi transversim depressus, medio paullulum dilatatus, tuberculo mediano brevissimo, obtuso vel acuto. Elytra maxime elongata, postice angustata, apice oblique truncata, dorso simplici vel ante medium utrinque tuberculo spiniformi. Prosternum arcuatum, mesosternum sat latum, antice declive. Acetabula antica angulatim hiantia; intermedia subclausa. Pedes modice elongati; femora gradatim parum clavata, posteriora brevia; tibiæ intermediæ elongatæ graciles, extus medio conspicue sinuatæ; tarsi posteriores elongati, art. primo cæteris 3 conjunctis æquali.

Allied to *Polimeta* (Pascoe), and, like that genus, having the elytra sometimes with and sometimes without two long spine-like tubercles on the disk. It differs, however, in the upper part of the forehead, which in *Polimeta* forms a raised transverse elevation produced by the coalescence of the antenniferous tubercles. The genus is allied, on the other hand, to *Rhopaloscelis* in all essential characters.

ERYSSAMENA SAPERDINA, n. sp.

Nigra, pube adpressa fuscescenti-grisea vestita, erecte nigro-setosa, antennarum articulis 3–11 basi albo-testaceis; thorace sparsim nigro-piperito, tuberculo mediano vix elevato, obtuso; elytris sparsim setifero-punctatis, punctis nigro-marginatis, fasciisque duabus nigris, prima latiori paullo post medium, secunda angustiori undulata ante apicem, dorso inermi, apice dehiscen-

tibus, oblique truncatis angulo externo subproducto. Long. 10–12 millim.

Chiuzenji; Usui-togé.

Besides the black setiferous punctures, the elytra have a few simple colourless punctures, mostly in lines.

ERYSSAMENA ACUTA, n. sp.

Ab *E. saperdina* differt thoracis tuberculis medianis acutis, elytrisque fascia posteriori nulla, anteriori ad suturam late interrupta. Griseo adpresso-pubescens, nigro-punctulata; antennis piceo-rufis, articulis 3–11 basi albo-testaceis. Long. 12½ millim.

Usui-togé.

Probably a variety of the preceding.

ERYSSAMENA SPINIDORSIS, n. sp. (Plate II. fig. 10.)

Nigra, griseoad presso-pubescens, nigro-setosa, punctis setiferis nigro-cinctis apud thoracem et elytrorum basin asperatis vel acute tuberculatis; thoracis tuberculis medianis vix elevatis obtusis; elytris sicut in *E. saperdina*, sed utrinque versus basin tuberculo spiniformi armatis, fasciaque nigra unica paullo post medium; femoribus fortius clavatis. Long. 10–13 millim.

Agematsu; Usui-togé.

MICCOLAMIA, nov. gen.

Corpus parvum, subcylindricum, ex parte glabrum, sparsim longe setosum. Caput exsertum, fronte convexa, tuberibus antenniferis late separatis; oculi reniformes, grosse granulati. Antennæ corpore paullo longiores, sparsim setosæ, scapo brevi, ovato, articulo secundo sat elongato, 3 et 4 cæteris singulatim longioribus. Thorax cylindricus, tuberculo mediano valido acuto. Elytra apice rotundata, carinula centrali-basali plus minusve elevata, dorso anteriori depresso, posteriori convexo. Pro- et mesosterna sat lata et plana; acetabula antica late hiantia, intermedia clausa. Pedes breves; femora clavata; tibiæ intermediæ et posteriores extus ante apicem profunde sinuatæ et setosæ; tarsi breves et lati, posteriorum art. primo quam secundus vix longiori, unguibus divaricatis.

The only described genus to which this new form can be said to be closely allied is *Phlyarus* (Pascoe) from Borneo. The short ovate form of the antennal scape and deeply sinuated outer edge of the four hinder tibiæ are the same in both genera.

MICCOLAMIA CLEROÏDES, n. sp. (Plate II. fig. 11.)

Castanea, nitida, antennis pedibusque fulvo-rufis, elytris dimidio basali fulvo-rufo, fascia recta postmediana cano-pubescenti, plaga magna apicali grisea; oculis lobo inferiori angustato; capite et thorace lævibus politis, illo inter antennas subplano, hoc valde convexo; elytris punctato-striatis, carina utrinque subbasali valde elevata penicillata. Long. 4 millim.

Idzu; Nikko.

MICCOLAMIA VERRUCOSA, n. sp.

Pube sericea adpressa vestita, sparsim longe setosa; nigra, elytris fulvis, basi et lateribus nigris; antennis piceo-rufis, scapo articulorumque apicibus fusco-nigris; pedibus nigris, tibiis basi tarsisque rufescentibus; capite inter antennas subconcavo; thorace convexo, dorso inæquali, tuberculato; elytris striato-punctatis, carina subbasali obtusa, interstitiisque alternis seriatim nigro-verrucosis. Long. $3\frac{1}{2}$–$4\frac{1}{2}$ millim.

Suyama; Tokio.

MICCOLAMIA GLABRICULA, n. sp.

Precedenti proxime affinis; differt corpore supra fere glabro, elytris nigris, plaga communi apiceque fulvis, verrucis paucioribus et minus elevatis. Long. $4\frac{1}{2}$ millim.

Nikko.

Probably only a variety of *M. verrucosa*, notwithstanding the striking difference in appearance between the two forms, due to the scantiness of the pubescence and the smaller and fewer elytral tubercles.

CLYTOSEMIA, nov. gen.

Corpus parvum, gracile, subdepressum, subtiliter adpresso-pubescens, nec setosum. Caput exsertum, inter antennas concavum, fronte brevi; oculi reniformes. Antennæ tenues, elongatæ, infra sparsim ciliatæ; scapo brevi, oblongo-conico sed extra basin sinuato-angustato; articulis 3–11, omnibus sat elongatis, gradatim decrescentibus. Thorax elongatus, medio dilatatus, tuberculo mediano valido. Elytra postice angustata, apice dehiscentia singulatim acuminatim-rotundata, basi (margine humerali elevato excepto) valde depressa, carina utrinque centro-basali valida, subconica. Pedes sat elongati; femora late dilatata; tibiæ intermediæ extra medium tuberculatæ deinde ad apicem hirsutæ; tarsi postici angusti, articulo primo cæteris tribus æquali.

Undoubtedly allied to *Ostedes*, *Polimeta*, and *Rhopaloscelis*, but

differing in the absence of erect hairs or setæ. The lateral tubercles of the thorax are exactly median, and not at all directed rearward but rather forward, and the thorax is narrowed near the base. The genus has very little in common with *Driopea* (Pascoe), although the species on which it is founded resembles somewhat in markings *D. clytina.*

CLYTOSEMIA PULCHRA, n. sp. (Plate II. fig. 9.)

Nigra, elytris griseis, fascia lata submediana (antice valde obliquata et suturam haud attingenti), macula magna ante apicem alteraque infrahumerali, nigris; antennis testaceo-fulvis. Long. 5½ millim.

Nikko.

ACANTHOCINUS STILLATUS, n. sp.

Griseo adpresso-pubescens, elytris guttis numerosis fasciaque postmediana dentata, nigris; antennis nigris, scapo basi griseo, art. 3–11 basi carneo-griseis.

♀ ovipositor segmento ventrali apice integro.

Long. (ovipos. excl.) 9 millim. ♂ ♀.

Chiuzenji; Junsai; Nikko.

CALLAPŒCUS, nov. gen.

Subfam. *Acanthoderinæ* pertinet, antennarum scapo pyriformi. Pro hac subfamilia parvus; oblongus sat convexus. Frons lata et brevis. Oculi grosse granulati. Antennæ graciles, corpore duplo longiores, subtus parcissime setosæ, articulis 3–4 elongatis, cæteribus brevioribus tenuibus, gradatim decrescentibus. Thorax transversus, tuberculis lateralibus validis acutis, alteris duabus dorsalibus. Elytra basi thoracis duplo latiora, apice rotundata, carinis centro-basalibus perparum elevatis. Pro- et mesosterna sat lata arcuata. Femora abrupte clavata.

I know of no genus at all nearly allied to this; it has no *prima facie* resemblance or close affinity to *Acanthoderes.*

CALLAPŒCUS GUTTATUS, n. sp. (Plate II. fig. 1.)

Fusco-niger, griseo adpresso-pubescens, elytris guttis numerosis nigris, antennarum articulis 3–11 basi carneo-griseis; thorace confertim punctulato, elytris paullo grossius, hic illic sublineatim, punctatis, interstitiis nonnullis medio disco perparum elevatis; tibiis dimidio basali carneo-griseo. Long. 8 millim.

Nara.

AGAPANTHIA ANGUSTICOLLIS, *Gyllenhal*, *Schönh. Syn. Ins.* i. 3, *App.* p. 189.

Junsai, on thistles.

Agrees with East-Siberian examples of this species, referred to Gyllenhal's species by Blessig and Kraatz, except in being of rather larger size and more robust.

CALAMOBIUS JAPONICUS, *Bates*, *Ann. & Mag. N. H.* ser. 4, vol. xii. 1873, p. 383, = Pseudocalamobius id., *Kraatz*, *Deutsche ent. Zeit.* 1879, p. 94.

The generic separation of *C. japonicus* from the European species *C. gracilis*, as proposed by Kraatz, is an improvement; *C. japonicus* differing by its broader head and non-retracted fore-head. But his remark about *C. japonicus* being a linear *Phytæcia* is seriously misleading. It may be a linear *Agapanthia* like the European *Calamobius*; but to place it in the *Phytæciides* group would be to make all classification of the Lamiidæ impossible. It is probable that *Calamobius* and *Pseudocalamobius* are links connecting the *Hippopsinæ* with the *Agapanthinæ*.

SAPERDA DECEMPUNCTATA, *Gebler*, *Reis.* ii. 3, p. 186; *Blessig*, *Horæ Ent. Ross.* ix. 1873, p. 219.

Yezo (*Pryer*). Two examples of this Siberian species agreeing precisely with the descriptions above cited.

SAPERDA TETRASTICTA, *Bates*, *Ann. & Mag. N. H.* ser. 5, iv. p. 466.

Junsai.

SAPERDA SULPHURATA, *Gebler*, *Bull. Mosc.* 1848, p. 405; *Blessig*, *Horæ Ent. Ross.* 1873, p. 223.

Junsai; Nanai. Found throughout Siberia and Manchuria, from Barnaul to Lake Khinka. Feeds on the *Rhus*.

Belongs to the genus *Menesia* (Muls.) according to Ganglbauer, Bestimmungs-Tabellen d. Europaïschen Coleop. viii., Cerambycidæ, ii. p. 151.

SAPERDA OCTOMACULATA, *Blessig*, *Horæ Ent. Ross.* ix. 1873, p. 221.

Junsai. Recorded by Blessig from the Middle Amur in E. Siberia.

SAPERDA SANGUINOLENTA, *Thomson.*
South and Central Japan and Yezo; on *Alnus.*

EUTETRAPHA, nov. gen.

A gen. *Saperda* differt elytris lateraliter carinatis. Segmenta ventralia 1–4 subæqualia; unguibus simplicibus; elytris apice rotundatis vel breviter et obtuse truncatis.

Closely allied to *Saperda tremula* and *punctata*, and differing solely in the carinated sides of the elytra. The genus includes, besides the following, *Saperda carinata* (Blessig), *S. metallescens* (Motschulsky), and *Glenea ocelota* (Bates).

EUTETRAPHA VARIICORNIS, n. sp.

Saperdæ carinatæ (Blessig) simillima et proxime affinis: differt solum articulis 3–6 apice nigris. Long. 12–20 millim.

Junsai; on a large *Senecio.*

Like *S. carinata*, of linear-oblong form, with carinated sides to the elytra, and clothed with dense ochreous or greyish-ochraceous felt-like pubescence and erect black hairs, the thorax having four black spots (in quadrangle) on the disk and a short fine black line on each flank, the elytra each with seven small angular black spots.

EUTETRAPHA CHRYSARGYREA, n. sp.

E. metallescenti affinis. Squamulis supra aurescenti-viridibus, subtus (cum femoribus) argenteo-auratis splendidissimis, vestita, et passim erecte pilosa. Thorace maculis 4 (in linea transversa), elytris utrinque humeris et carinis, maculisque 4 in linea dispositis (tertia angulata et elongata plerumque cum quarta conjuncta, cæteris rotundatis) nigris, carinis utrinque duabus (inferiori antice abbreviata postice cum superiori conjuncta) validis, margineque incrassato; antennis nigris partim griseo-pubescentibus; tibiis et tarsis viridi-griseis, illis apice nigris. Long. 12–17 millim. ♂ ♀.

On Oyayama in Higo.

Approaches *Glenea* more nearly than any of the other species, the first ventral segment being somewhat longer than either of the three following; the apices of the elytra are, however, very obtusely and narrowly truncated.

PARAGLENEA CHRYSOCHLORIS.—Glenea chrysochloris, *Bates, Ann. & Mag. N. H.* ser. 5, vol. iv. p. 467.

Yezo; Chiuzenji.

Resembles *Eutetrapha chrysargyrea* in its black markings and the form and colour of the elytral carinæ; the spots are, however, much larger, the elytra have the external angle of the truncature briefly spinose, and the claws in the male have a short and broad, but sharp tooth at the base, the claws in the female alone being simple.

PARAGLENEA EXIMIA, n. sp.

Anguste oblongo-linearis, squamulis argenteo-viridibus vestita, erecte (postice brevius) pilosa, media fronte et occipite nigris. Thorace maculis magnis elongatis 4 in linea transversa, elytris utrinque vitta marginali maculisque oblongis subæqualibus et subæquidistantibus 4, nigris, pectore ventroque medio nigris; antennis pedibusque griseo-nigris, scapo articuloque tertio extus femoribusque supra cæruleis: supra punctulata, elytris apice singulatim rotundatis, carina laterali obsoleta sed epipleuris verticalibus grosse punctato-striatis; unguibus ♂ ♀ basi late et acute dentatis. Long. 11–12 millim. ♂ ♀.

Junsai; Sapporo.

Distinguished from the allied metallic squamose species by the large size and regularity of the four black spots of the elytra.

PARAGLENEA THEAPHIA, n. sp.

Brevius oblongo-linearis, nigro-fusca, nitida, adpresso-pubescens et erecte pilosa capite et thorace sulphureis, fronte late thoraceque plaga angulata mediana vittaque laterali, nigris; scutello sulphureo; elytris utrinque maculis 6 (prima basali, secunda rotunda prope basin et suturam, tertia mediana, quarta postmediana elongata obliqua, quinta exteriori punctiformi, sexta ante apicem transversa), vitta angusta submarginali (post humeros incipienti prope apicem cum macula sexta conjuncta) lunulaque apicali, sulphureis; antennis nigris; pedibus pallide rufis: corpore subtus dense cinereo-pubescenti; elytris confertim punctulatis, carina laterali tenui, abbreviata; unguibus (♀ ?) basi dente lata, acuta. Long. 10½ millim.

Sapporo.

Scarcely belongs to *Paraglenea*, the sides of the elytra not being vertical, and the carina which separates them from the disk being only slightly elevated and very incomplete. The species has the habit of a true *Saperda* rather than a *Paraglenea*, but cannot be included in that genus owing to the toothed base of

the claws. The legs and tarsi are remarkably short. I am unwilling to found a new genus on a single example of doubtful sex, in such a group as the *Saperdinæ*.

The genus *Paraglenea* was imperfectly defined by me in Proc. Zool. Soc. 1866, p. 352, and has not been adopted by entomologists. It is, however, sufficiently distinct from *Glenea* in the toothed claws in both sexes (the tooth being generally very short) and in the equal length of the first four ventral segments.

GLENEA COLENDA, *Thomson, Rev. Zool.* 1879, p. 15.

Japan.

I have not seen anything resembling this species in Mr. Lewis's or other collections.

SINGALIA RUFESCENS, n. sp.

Testaceo-rufa, antennis elytrisque fusco-rufis; thorace antice valde gibboso aspere punctato, elytris creberrime subconfluenter punctulatis, apice utrinque in spinam productis, obsolete costulatis. Long. 14 millim.

Nagasaki.

Differs from *S. spinipennis* (Lac.), from Ceylon, in the uniform colour of the elytra. In their peculiar structure the two species, judging from Lacordaire's description, perfectly agree.

STENOSTOLA ARGYROSTICTA, n. sp.

Nigra, nitida, erecte pilosa, thorace linea laterali elytrisque maculis utrinque quinque (prima parva basali, secunda paullo posteriori parva oblonga, tertia majori ovata mediana, quarta ovata paullo obliqua longe post medium, quinta parva apicali) argenteo-viridi-tomentosis. Capite crebre punctato, infra oculos viridi-argenteo; thorace parvo, cylindrico, basi subconstricto, crebre punctato; elytris discrete punctatis, apices versus lævibus; pectore argenteo-viridi vittato; antennis nigris; pedibus gracilibus nigris; tarsis posticis argenteo-viridibus, unguibus basi latissime dentatis. Long. 12 millim.

Chiuzenji.

Agrees with *Stenostola nigripes* in form and structure, but differs in the claws being toothed like *Oberea*.

The species seems to approach Solsky's genus *Eumecocera*, founded on a Siberian species with uniform silvery-green adpressed pubescence on the elytra; but it has not the fine "setiform" antennæ attributed to *Eumecocera*, these organs in *S. argyrosticta* being very similar to those of *S. nigripes*.

STENOSTOLA ANOMALA, n. sp.

Linearis, postice paullo angustata, nigra, erecte pilosa, elytris fulvo-castaneis, thorace argenteo-viridi trilineato, linea mediana per scutellum ducta; antennis (♀) corpore longioribus, basi undique pilosis, articulis 4–11 subæqualibus sat elongatis: capite thoraceque discrete punctatis, hoc relative parvo, cylindrico; elytris apice breviter obtuse truncatis, dorso subplanis sat confertim grosse, lateribus lineatim, punctatis; unguibus sicut in *S. argyrosticta* late dentatis. Long. 9 millim.

Higo.

The species does not fit well the genus *Stenostola*, but it approaches it nearer than it does any other described genus. In form, facies, and punctuation of the sides of the elytra it resembles many *Gleneæ*, but differs in its toothed claws and the want of elytral carinæ.

EPIGLENEA, nov. gen.

Facies gen. *Gleneæ*; sed differt unguibus basi late dentatis elytrorumque lateribus haud carinatis confuse punctatis. Corpus cylindricum erecte pilosum, tomentoso-maculatum. Caput thorace latius, fronte infra oculos paullo angustata; oculi convexi. Antennæ corpore longiores, ciliatæ, art. tertio quam scapus paullo longiori, 4–11 elongatis, gradatim decrescentibus. Thorax cylindricus, basi angustatus. Elytra postice parum angustata, supra subplanata, lateribus nullomodo carinatis, omnino sat crebre confuse punctata, apice breviter truncata et utrinque bidentata. Prosternum inter coxas angustissimum; coxæ conicæ exsertæ; mesosternum modice latum. Ventris segmenta 1–4 æqualia, quinto elongato medio sulcato. Tibiæ intermediæ extus subintegræ; tarsi breves, unguiculis divaricatis, ♂ ♀ basi latissime dentatis.

The combination of characters above described forbids the location of the species about to be described in any of the known genera of *Saperdinæ*. In general form and markings it nearest resembles *Glenea*, but the claws are toothed as in *Oberea* and some aberrant *Phytæciæ*, and in the two species I have provisionally associated with *Stenostola*.

EPIGLENEA COMES, n. sp.

Nigra, fusco erecte pilosa, fronte margineque oculorum, thoracis vittis tribus, scutello elytrorumque utrinque vitta

centrali a basi usque ultra medium extensa maculisque transversis duabus inter vittam et apicem, sulphureis, lineola submarginali marginibusque griseis: subtus sulphureo-pubescens; antennis nigris; pedibus rufis. Long. 10½ millim.

Higo.

Oberea vittata, *Blessig, Horæ Soc. Ent. Ross.* ix. 1873, p. 223.—O. sylvia, *Pascoe, Trans. Ent. Soc.* ser. 2, iv. p. 261?

Yokohama; Yuyama; Nagasaki.

Agrees with Blessig's description of the Manchurian insect and also with an example I have received from the Amur. The apex of the elytra is truncated, and "mehr oder weniger ausgerandet." In the sinuation of the elytral truncature and the longer or shorter prolongation of the angles of the truncature there are differences in Mr. Lewis's specimens; but it seems probable the sinuation is stronger in the Japanese than in the continental form.

Oberea hebescens (Bates) is very closely allied to this species, but is distinguishable by its yellow undersurface (except apical ventral segment), *O. vittata* having the breast and middle of the ventral segments always blackish, and by the dark lateral vitta not quite covering the shoulders of the elytra.

Oberea niponensis.—O. japonica, *Bates, Ann. & Mag. N. H.* 1873, p. 388 (nom. præocc.).

The name *japonica* was preoccupied by Thunberg, whose *Saperda japonica* appears to be an *Oberea*. Kraatz considers *O. marginella*, Bates, to be "probably" Thunberg's *S. japonica*. The very insufficient diagnosis given by Thunberg appears to have led to his species being omitted by all recent writers on the Longicornia. It is not entered in the Munich Catalogue.

Oberea sericans, n. sp.

O. marginellæ, Bates, quoad formam et sculpturam simillima; differt thorace nigro sat crebre punctato, nitido, corporeque subtus fere toto fusco-nigro. Pro hoc genere brevis, erecte pilosa, elytris subtiliter incumbenti-sericeo-pubescentibus; capite thoraceque nigris nitidis conspicue punctatis; scutello nigro; elytris sat late sinuato-truncatis, confuse (dorso versus basin tantum subseriatim) punctatis, carinula laterali obsoleta, fulvis, vitta laterali (humeros haud attingenti) nigris, et parte

apicali interdum fusco suffusa; antennis fulvis, articulis 1–2 nigris, vel fere toto nigris: subtus fusco-nigro. Long. 10–12 millim.

Otaru; Nanai; Junsai.

Kraatz suggests that *Oberea marginella* would be better placed in *Nupserha*. It is, in fact, like so many other Japanese Longicorns, a connecting link between two genera. The sculpture is more that of an *Oberea*.

PRAOLIA, nov. gen.

Gen. *Serixiæ* affinis et similis; sed differt tarsorum unguibus late et breviter dentatis. Corpus cylindricum, erecte pilosum, elytris sericeo adpresso-pubescentibus. Caput thorace latius; oculi magni, convexi; vertex et frons plana. Antennæ corpore plusquam duplo longiores, tenuiter filiformes; scapo art. tertio subæquali, cæteris a quarto paullo crescentibus. Thorax breviter cylindricus, postice angustatus. Elytra cylindrica, apice rotundata, seriatim punctata. Pro- et mesosterna angusta sed perspicua; metasterni episterna antice haud dilatata, elongato-oblonga, postice subangustata. Ventris segmenta fere æqualia. Femora parum incrassata; tibiæ intermediæ extus versus apicem sinuatæ; tarsi breves et lati, unguibus divaricatis basi late et brevissime dentatis.

Allied to the Indo-Malayan genus *Serixia*, the narrower subcylindrical species of which it much resembles. But *Serixia* and its allied genera or sections (*Iole*, *Xyaste*) have simple claws; in *Praolia* the tooth of the claws is not like that of *Oberea* or of *Phytæcia*, but is a dilatation of the base with a distinct angular or pointed edge.

PRAOLIA CITRINIPES, n. sp. (Plate II. fig. 8.)

Nigra, dense et minus subtiliter sericeo-griseo pubescens et erecte pilosa; capite thoraceque rufis, subnudis, sparsim punctatis, antennis nigris, articulis a quarto basi pallidis; pedibus citrino-flavis, tibiis apice et tarsis basi fuscis.

Kashiwagi; on *Celtis*.

There remain in Mr. Lewis's collection a few species certainly different from any yet described from Japan, but requiring further, and in some cases more perfect, specimens before they can be described. They are as follows:—

1. A *Grammoptera*, a single specimen, doubtful if not an extreme variety of *G. amentata*.

2. A small species of the group *Monohamminæ*, one imperfect example.

3. A species apparently allied to *Cylindilla*.

4. An imperfect specimen of a species possibly of the group *Niphoninæ*.

The following is indeterminable:—

POGONOCHERUS GRANULATUS, *Motsch. Bull. Mosc.* 1866, i. p. 174.

From the description it cannot belong to the genus *Pogonocherus*.

DESCRIPTION OF THE PLATES.

PLATE I.

Fig. 1. Xenophyrama purpureum.
2. Corennys sericata.
3. Psephactus remiger ♂.
4. Eustrangalis distenioïdes ♀.
5. Lemula decipiens.
6. Toxotinus longicornis.
7. Encyclops olivaceus.
8. Pyrrhona læticolor.
9. Phlyctidola metallica.
10. Dolophrades terrenus.
11. Paraclytus excultus.
12. Aglaophis colobotheoïdes.

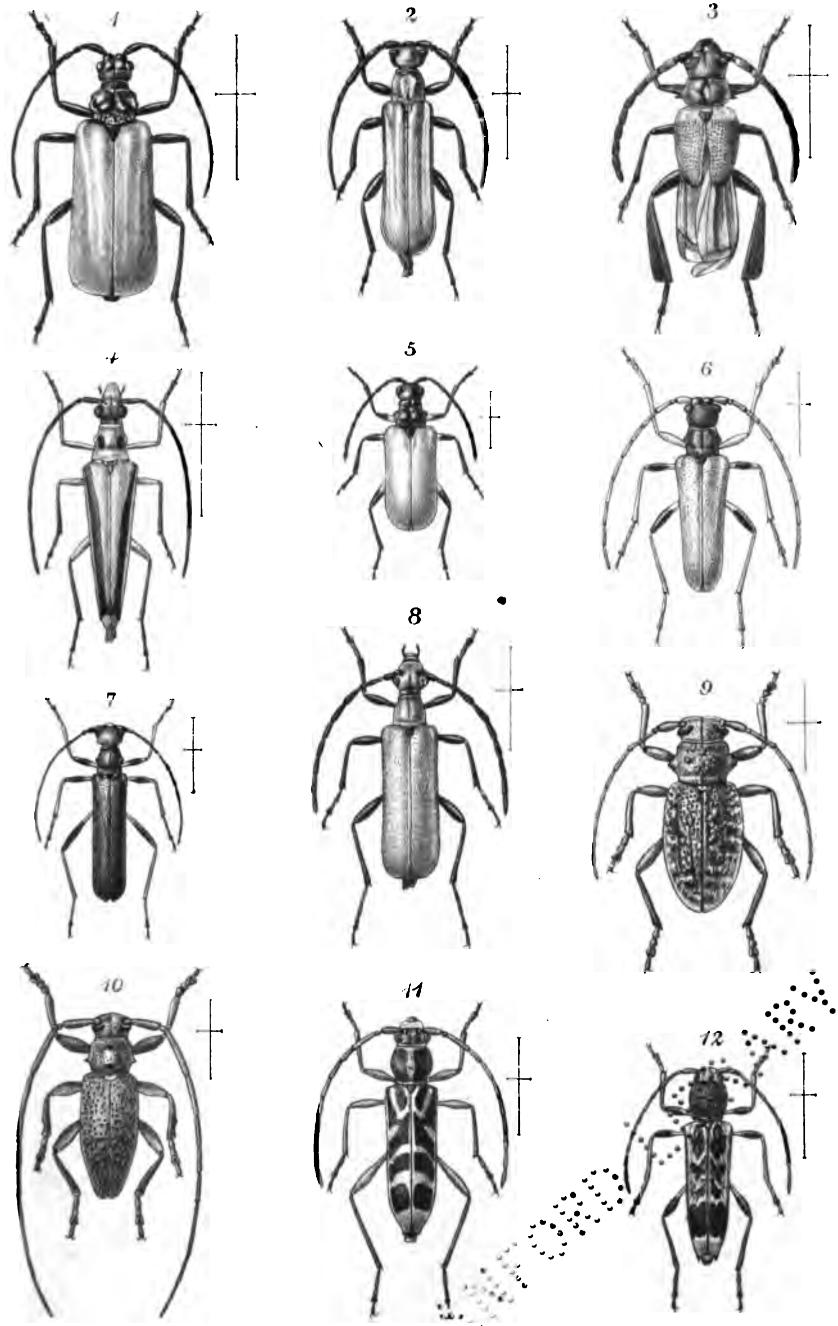
PLATE II.

Fig. 1. Callapœcus guttatus.
2. Xeniootela fuscula.
3. Mesosella simiola.
4. Nanohammus rufescens.
5. Apalimna liturata.
6. Terinæa atrofusca.
7. Xylariopsis mimica.
8. Praolia citrinipes.
9. Clytosemia pulchra.
10. Eryssamena spinidorsis.
11. Miccolamia cleroïdes.
12. Mecynippus pubicornis.

On the Influence of Wave-currents on the Fauna inhabiting Shallow Seas. By ARTHUR R. HUNT, M.A., F.G.S. (Communicated by Dr. J. GWYN JEFFREYS, F.R.S., F.L.S.)

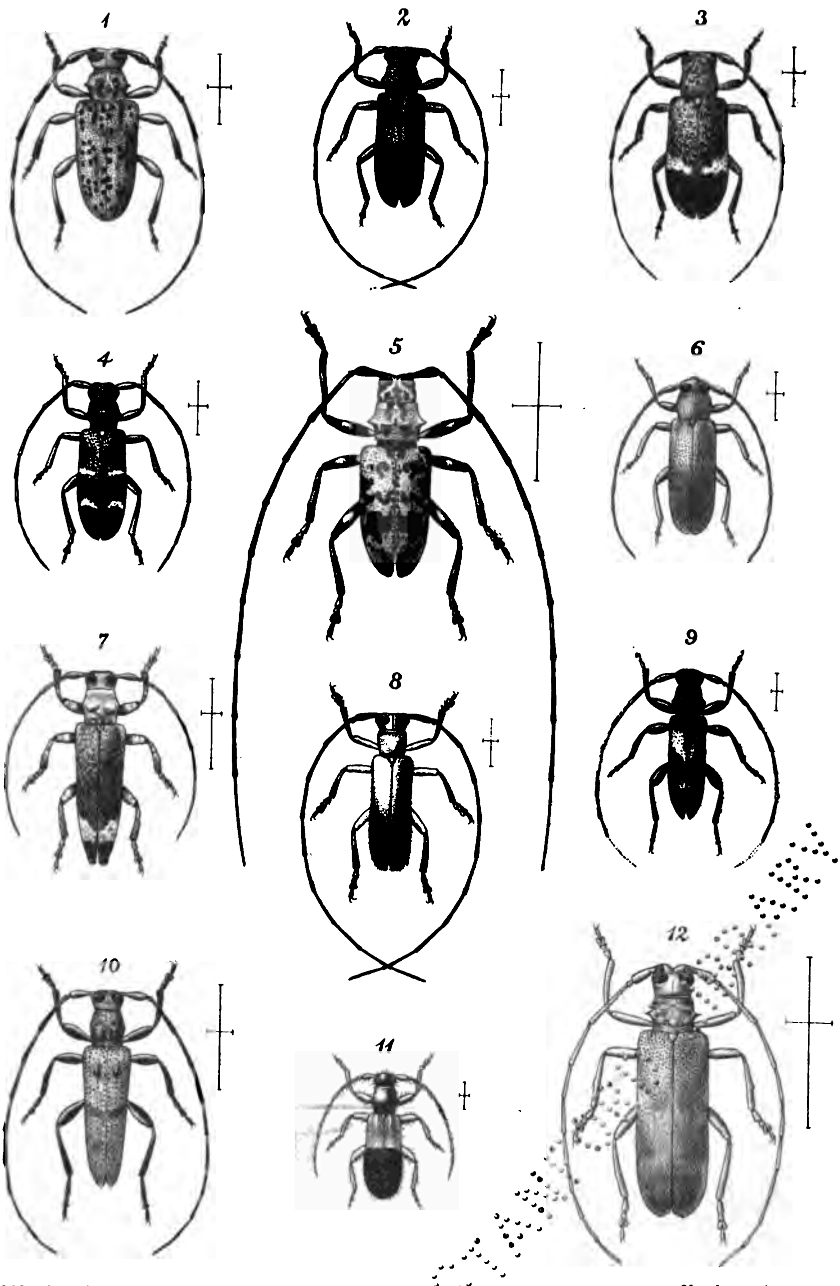
[Read 5th June, 1884.]

THE action of waves below the surface of the water decreases so rapidly as the depth increases that naturalists have been in the habit of neglecting submarine wave-action altogether. In proof of this I may refer to Sir Charles Lyell's assertion that "the agitation caused by waves, even during storms, extends to a very slight depth" ('Elements of Geology,' 6th ed. p. 20); and to Dr. Günther's statement that "the agitation of the water caused by



W.Purkiss lith. Hanhart imp.

NEW LONGICORNS FROM JAPAN.



W. Purkiss lith. Hanhart imp.

NEW LONGICORNS FROM JAPAN.

the disturbances of the air does not extend beyond the depth of a few fathoms," and that "below this surface-stratum there is no other movement except the quiet flow of ocean-currents" ('Introduction to the Study of Fishes,' p. 298).

In a paper published in the 'Transactions of the Devonshire Association' in 1883 I described a glass bottle trawled in 40 fathoms in the English Channel, and endeavoured to prove, from its condition and contents, that it had been subjected to alternate periods of wave-disturbance and of repose ("The Submarine Geology of the English Channel off the Coast of South Devon," Part III., Trans. Dev. Assoc. vol. xv. pp. 359–365). Professor G. G. Stokes, Sec. R.S., has been so good as to peruse the paper referred to, and to favour me with a letter on the subject of wave-disturbance on the sea-bottom, from which the following is an extract. Referring to waves with a period of 17 seconds (such as he had himself had an opportunity of observing), and acting at a depth of 40 fathoms, Professor Stokes writes:—

"Lensfield Cottage, Cambridge,
18 Jan., 1884.

". . . I find for the velocity of propagation of the waves 87·14 feet per second in the deep, and 73·05 in the shoal, or 59·41 miles per hour in the deep, and 49·13 in the shoal. Also, for the ratio of the velocity at the bottom to the velocity at the surface 0·5332 to 1. As to the actual velocity at the surface, that will depend on the height we assign to the waves. Taking it as eight feet above or below mean level in the shoal, 16 feet from crest to trough in all, I find a velocity of 1·989 miles per hour at the surface, and 1·036, say 1 mile, an hour at the bottom. The height may, however, well be greater than what I have assumed, and the velocity will be greater in proportion.

"But even a velocity of only 1 mile per hour might make a material difference if combined with a tidal current. Thus, suppose we had a tidal current running 2 miles an hour, approximately in the same direction as the waves are travelling in, or in the contrary direction. Then, whereas with the tide alone we should have a steady current of 2 miles, and with the waves alone a reciprocating flow of 1 mile, with the two together we should have a flow rapidly changing between 1 mile and 3 miles. Now, taking the resistance to vary as the square of the velocity, the 3-mile current would have two and a quarter times as much power to roll over a shell or bottle as the tidal current alone; and, moreover, this

current would be rapidly shifting, so that a bottle would be continually moving about if the water were able to move it at all. I think therefore that, even with a depth as great as 40 fathoms, the effect of the waves is not to be disregarded, at least in the case of a locality subject to oceanic swells, and where there is a sensible tidal current as well. It is likely enough that it is only in the case of a specially heavy ground swell that the effect of the waves would be liable to be significant. . . . I need hardly say that if the depth be less than what I have supposed, the proportion of wave-velocity to that at the surface for a given period of wave will be greater than the eight fifteenths I have calculated for the case chosen, and that same proportion of eight fifteenths would be attained for waves of a smaller period than 17 seconds."

As Professor Stokes has referred to wave-currents of 1 mile per hour as being possible at a depth of 40 fathoms, it may be as well to state what effect such currents would be capable of producing, without taking into account the increase in power due to their reciprocal character.

According to Minard, quoted by Mr. T. Stevenson ('On Harbours,' p. 238), a current of 0·6819 mile per hour will sweep along fine gravel, and a current of 1·3638 mile an hour will roll along rounded pebbles 1 inch in diameter. Thus the 1-mile current is more than sufficient to roll along fine gravel.

There is thus no lack of evidence that the power of wave-currents at a depth of 40 fathoms is occasionally considerable; that it is by no means exhausted at that depth; and that, for the occasional disturbance of a sandy bottom, the depth of 50 fathoms may be attained, or even exceeded.

The extreme limit of depth affected by wave-currents is of minor importance in the present inquiry; it will suffice if it be conceded that appreciable wave-disturbance is occasionally experienced on the sea-bottom at the depth of 50 fathoms.

The occasional existence of such alternating currents being granted—and of their presence between tide-marks and in shallow water any observer can have ocular demonstration—we proceed to inquire whether the fauna inhabiting shallow and exposed seas is to an appreciable extent influenced by them. From the limited observations I have been able to make, I am disposed to think that the marine fauna referred to is influenced by such wave-currents to an extent that it is scarcely possible to overrate.

The marine fauna exposed to the action of waves may be conveniently divided into two groups of animals, viz. those that live on the tidal strand, and those that live in, or on, the sea-bottom outside tide-marks.

(1) *Animals Living on the Tidal Strand.*

These may be further considered under the following heads, viz.:—

(*a*) Animals living on rock or other firm foundation; and
(*b*) Animals living in sand or other incoherent deposit.

(*a*) *Animals living on a Firm Foundation.*—The methods by which animals living on, or in, rocks resist the attacks of waves are so well known that they need not occupy our attention. Suffice it to say that among them are included great powers of permanent attachment, as evidenced by the oyster and mussel; of temporary attachment, as evidenced by the limpet and sea-anemone; and of boring, as evidenced by the pholas and other rock-boring mollusks.

(*b*) *Animals living in Sand.*—The habitat being unstable under the attacks of waves and currents, no powers of attachment will serve the inhabitant. Safety lies in the celerity with which the animal can penetrate the sand, either to avoid being washed away in the denudation of the deposit, or to force its way to the surface through any accumulation that may be piled over it. We have a good example in the case of *Solen vagina*, one of the most active of mollusks in penetrating the sand in which it lives. Describing the genus, Dr. Gwyn Jeffreys observes:—"When the Solen is disturbed it . . . . . rapidly disappears below the surface to a depth of two or three feet" (Brit. Conch. vol. iii. p. 13).

(2) *Animals living at the Sea-bottom outside Tide-marks.*

The case of a rocky bottom needs no consideration, as the protection afforded is as great as on the tidal strand, whereas the wave-currents are weaker. There remains to consider the case of

(*c*) Animals that live in a sandy or muddy bottom, or have the power of burrowing into it; and (*d*) that of animals which live on the surface of the bottom.

(*c*) *Animals that live in a sandy or muddy bottom outside*

tide-marks find their safety in their power of maintaining themselves to a greater or less extent below the surface of such bottom. This position of safety is attained in two ways, viz. either by the power of the animal to burrow rapidly in the deposit in which it lives, or by its power of retaining a safe position when once secured. Mr. Osler, referring to the burrowing of bivalves, has observed that "animals which from their small size or the little depth at which they reside are particularly liable to be exposed, will generally burrow readily; but the large species will scarcely attempt to bury themselves, except in the very young state" (Phil. Trans. 1826, p. 348). Irrespective of age, activity in burrowing varies greatly in different instances. This can be well seen in the case of the young of different species of *Cardium*, and in that of full-grown specimens of *Psammobia tellinella*. The compressed valves and hatchet-like form of the latter are clearly suited for rapid penetration, whereas the comparatively globular form of the Cardium is as evidently ill adapted to force its way through a resisting medium. As a matter of fact, when in captivity the cockles burrow very sluggishly, if at all, whereas the Psammobias do so most readily. In their natural homes the latter seek to escape by evading the wave-currents, the former to a great extent by passive resistance. *Psammobia tellinella* abounds in a deposit consisting of comminuted shells and small stones which occurs in the vicinity of Hope's Nose, the northern horn of Torbay, the materials being accumulated by strong currents. Through this deposit the *Psammobia* forces its way with great ease. If it were otherwise it is difficult to see how it could survive, as the character of the accumulation is sufficient proof of the amount of disturbance to which it is occasionally exposed.

The large cockle, *Cardium aculeatum*, is abundant in fine muddy sand off Paignton in Torbay. In this deposit the long spines of this species are of service to increase its holding-powers. An allied species, *C. tuberculatum*, whose shell is rough and ribbed but not spined, dwells in hard sand at and below low-water mark off the same place. The two species are not commonly found living together, though I have found specimens of *C. aculeatum* that had been washed in from sea, and their spines denuded in the process, living side by side in the hard ground with *C. tuberculatum*. In both these species the rough shells tend to prevent the mollusks being readily dislodged by the waves. Each species keeps to the ground best suited to it. The spines of *C. aculeatum*

would apparently be too great an impediment in burrowing in the hard sand, whereas the spineless shell of *C. tuberculatum* would afford insufficient hold in the soft sand. A very slight advantage from form or sculpture might be of great importance in saving the cockles from local extinction; for in the case of Torbay the struggle for existence is so severe that both species are occasionally washed on shore in sufficient quantities to be carted away for manure.

Among the Veneridæ the following may be cited as provided with special mooring-apparatus, viz. *Venus casina* and *V. verrucosa*, with deep concentric ribs; and *Cytherea dione*, with concentric ribs and long spines in addition.

The two bivalves, *Psammobia tellinella* and *Cardium aculeatum*, are fair examples of active and passive resistance to the inroads of wave-currents by animals living close to the surface of the deposit which forms their habitat. Passive resistance in the case of the spinous cockles is facilitated by their ribs and spines, while it is supplemented by the powerful foot, which moors the animal to the sand and enables it to burrow in it, though at a comparatively low speed. Certain mollusks with smooth cells and sluggish habits, such as *Mya truncata* for instance, avoid the wave-currents by living at a safer distance below the surface of the bottom, being enabled to do this by means of the long tubes with which they are furnished. There can be no doubt that the long tubes possessed by many species of burrowing mollusks are valuable auxiliaries in self-defence, more especially in the case of the young, who, from their small size, would be affected by much slighter wave-currents than the adults, and would be in constant danger if obliged to live at the surface, or close to the surface, of the deposit that gave them shelter.

(*d*) *Animals that live on the Sea-bottom on Sand or Mud.*—This group of animals is more interesting, and at the same time more satisfactory to deal with, than either of those hitherto referred to. The special adaptations of structure to resist or evade wave-action exhibit great variety, while at the same time the animals themselves often offer the great advantage to the investigator of lending themselves to the test of experiment.

The following will serve for a few examples:—The Gastropod *Aporrhais pes-pelecani* is a sluggish mollusk that frequents exposed areas of sand a few fathoms below the surface of the water. Its long wing-like processes, jutting out on one side of the shell, though affording the animal a broad base on which to

rest, appear at first sight to be a source of danger in case it were overturned. They are in reality self-acting pieces of mechanism that will, in the majority of instances, ensure the mollusk being ultimately left in its normal posture should it encounter wave-currents sufficiently strong to upset it. On examining a specimen of *Aporrhais pes-pelecani* it will be seen that, when on its back, it lies indifferently on either side of a line drawn between two points, of which the end of the middle wing-like process is one, and one of the nodules on the body-whorl the other. The shell will rock freely backwards and forwards across this line; and experiment proves that a very moderate alternate current will suffice to replace the shell in its normal position. I have tried this experiment over and over again, not only with *Aporrhais*, but also with heavy foreign shells furnished with spines, processes, and more or less developed lips, such as *Murex*, *Pteroceras*, and *Strombus*. In many cases the righting-action of wave-currents is most marked.

With *Aporrhais*, on the same exposed areas, are often found the Gastropods *Natica catena*, *Buccinum undatum*, *Nassa reticulata*, *Bulla hydatis*, and *Philine aperta*. All these are manifestly unsuited to withstand wave-currents on the surface of the bottom; but there is no occasion for making the attempt, as all burrow freely, travelling through the sand beneath the surface.

Asterias aurantiaca and *Antedon rosaceus* are good examples of two Echinoderms that successfully encounter wave-currents by methods totally diverse. The *Asterias* lies on the sand with an extended and rigid base, where its flattened form is eminently calculated to offer slight resistance to wave-currents. But as though this were insufficient for its safety, it has the power of sinking vertically in the sand, and of thus securing itself from all danger. *Antedon rosaceus* (the feather-star) is found frequenting the clear water off rocky headlands, where it is necessarily exposed to strong currents, both tidal and wave-engendered. Here nothing will avail but sheer strength in holding on; and this the feather-star possesses in an eminent degree, from the time it is first attached to weed or zoophyte in its early stages of growth, to the time when, a full-grown adult, it is free to exercise its limited powers of locomotion. I may here refer to Mr. Osler's description of the *Spatangus* sinking vertically into the sand by the action of its short, flat bristles (Phil. Trans. 1826, p. 347).

Among the Crabs there are at least three methods adopted for resisting wave-currents.

The rock-crabs (*Cancer*) fix themselves firmly in crevices, where they can bid defiance to the strongest waves. The swimming-crabs (*Portunus*) shovel away the sand with their flat swimming-feet, and speedily gain protection under the surface; whilst the hermit-crabs (*Pagurus*), inhabiting empty shells, secure a fair hold on the bottom by the length of their legs, the latter being long in proportion to the size of the bodies of the crabs and their strange coverings.

Moreover, the swimming-crabs are quite alive to the advantages, as well as the disadvantages, of reciprocal currents. I have seen one of these crabs make a rapid passage seawards by swimming with the outward-flowing wave-current, and settling down between the sand-ripples on the bottom when the shoreward current commenced to flow.

Mr. Couch, referring to the habit of the masked crab (*Corystes cassivelaunus*) burrowing in the sand, and "leaving the extremities of its antennæ alone projecting above the surface," suggested that the antennæ might assist in the process of excavation. Having kept one of these crabs in confinement for some little time, I venture to doubt the accuracy of this explanation, seeing that they descend into the sand backwards with the greatest agility, and thus leave the antennæ no opportunity of assisting in the operation. I incline to think that the function of the antennæ is to maintain a communication between the buried crab and the water above, as without some such connexion there would be a risk of the animals being occasionally buried to a dangerous depth by the accumulation of sand above them *. Mr. W. Thompson's statement that the antennæ in very small specimens "are much longer in proportion to the carapace than in the adult" (T. Bell, 'British Stalk-eyed Crustacea,' pp. 161, 162) harmonizes well with this hypothesis, as to ensure safety the young would have to burrow to a greater depth compared with the adults than would be proportionate to their size.

* *Note.*—When writing the above, I was unaware that so long ago as 1865 Mr. P. H. Gosse, F.R.S., had criticised Mr. Couch's theory as to the antennæ of *Corystes*, and had expressed his own opinion that their use was "to keep a passage open through the sand from the bottom of the burrow to the superincumbent water" ('Year at the Shore,' pp. 127–131). I much regret the unintentional plagiarism. —A. R. H.

The special contrivances by which shallow-water fishes elude wave-currents are similar to those that obtain in the cases of the mollusks, echinoderms, and crustaceans already referred to, although, as the fishes are more active, they have not to depend so much on a passive resistance. The fish elude the waves either by attaching themselves to fixed objects, by hiding under stones, by burrowing in the bottom, or by lying quiet whilst the alternate wave-currents cover them with sand.

The burrowing-habits of the sand-launce, *Ammodytes lancea*, are well known. Frequenting, as these fish do, shallow water, and even burrowing in tidal strands where the waves have the greatest power, they could scarcely successfully encounter the broken water in the shallows if exposed to its violence, and unable to take refuge in the sand.

Another well-known and remarkable fish is the two-spotted sucker (*Lepidogaster bimaculatus*), which has the power of attaching itself firmly to fixed objects by means of its ventral fins. The special defence of this species against wave-currents is perfect, so long as it can find some immovable object to which to attach itself *.

Perhaps of all marine fishes the most interesting in their connexion with wave-action are the flat-fishes. They seem to have changed their original forms and habits for the purpose of being able to live in shallow waters agitated by waves; for it is well known that at first they swim vertically in the orthodox fashion.

All who have dredged for shrimps near the shore well know how abundant are the little soles, plaice, and dabs, from the size of a shilling upwards, that live on the same ground as do the shrimps, and have to conform to the same outward circumstances. If any of these little fish be placed in a vessel of sea-water with

* *Note.*—A specimen dredged in the gaping valves of a Pecten on July 5, 1884, stuck to its refuge whilst being dragged along the sea-bottom, hauled to the surface, and discharged with a dredgeful of dead shells on the boat's deck. This fish, when turned out of its shell in a small aquarium, would, on the water being rocked, manifest great anxiety to get back again. During a residence of more than a month in captivity it varied greatly in colour, from a decided red to a shade so pale as to make it an inconspicuous object when attached to the white interior of a Pecten-valve. Another specimen, dredged with algæ on rocky ground on July 20, was of an olive-brown colour. These fish are good examples of the protection against wave-currents afforded by form, and of the protection against animate foes afforded by colour.—A. R. H.

sand sufficient to cover the bottom, it will be seen how indifferent they are to oscillating currents, and how easily they evade them. They meet the danger either by flashing with great velocity under the sand, or by passive resistance, lying quite still whilst the sand-ripples formed by the rocking of the water cover them up. It has been thought that flat-fish cover themselves with sand for the purpose of concealment; but this hypothesis fails to meet the fact that among them are included many varieties, such as the halibut and skate, that grow to a large size, and can scarcely need to hide themselves from living foes. Moreover, such concealment cannot be assured to the feeblest of them, as the smallest and weakest have to move about after their own prey. Further, as the peculiar habit of swimming on the side, and the peculiar position of the eyes on the same side of the head, are not congenital, but acquired after the young are hatched, the latter when most exposed to be devoured by fish have not the benefit of the hypothetical means of protection from these enemies. On the other hand, when we see that these peculiar forms and habits afford a perfect protection against wave-currents, it seems reasonable to conclude that the said forms and habits have a very close connexion with the special dangers against which they are manifestly such efficient safeguards*.

Many of the visitors to the Southport Aquarium during the visit of the British Association in 1883 watched with interest the struggles of the king crabs (*Limulus*) to regain their normal position, when, by climbing the walls of their tank, they had fallen on their backs. It seemed anomalous that a crustacean should be so constituted as to be helpless in any position in its native element. Owing to the hemispherical form of the carapace of these crustaceans, no such difficulty would be experienced on an open coast in shallow water, as gentle wave-currents would suffice to restore them to position if by any chance upset.

* *Note.*—The following statement of Professor Moseley seems exactly in point:—". . . the young flat fish termed Platessæ . . . are often taken in the open ocean; and it appears probable that when there placed under unnatural circumstances, their development becomes arrested, and many probably perish eventually . . . . without the arrangement of their eyes ever becoming unsymmetrical. The deep sea is devoid of flat fish" . . . . (Nature, vol. xxvi. p. 563). It seems clear from the above that the horizontal position, unsymmetrical eyes, and quasi-burrowing habits of flat fish are peculiarities connected with their shallow-water habitats, and with them alone.—A. R. H.

In the foregoing pages I have called attention to the facts that wave-currents affect the bottom in shallow water, and that they are a source of danger to the fauna inhabiting such water; and I have adduced a few examples from my own limited experience of animals that are specially adapted to withstand the attacks of such wave-currents. It remains for me, in conclusion, to show how, under the influence of wave-currents, the variation of species may be promoted, and their local extinction brought about. The common spinous cockle, *Cardium echinatum*, will serve to illustrate the manner in which wave-currents may influence variation.

This species varies much in form and in length of spines. Mr. Gwyn Jeffreys describes two distinct varieties in addition to the type. The sand in which *C. echinatum* lives is also variable; it varies in size and character of grain, in specific gravity, and in the amount of its admixture with mud. Some localities are exposed to wave-currents, some to tidal currents, and some to both combined. Wave-currents acting alone, and giving rise to no general forward movement, sort and arrange the materials composing the bottom. Wave-currents in conjunction with tidal currents tend to produce a general motion of the bottom-deposit, if movable at all, causing denudation at one place and accumulation at another. A shell may withstand the local rearrangement of deposit caused by wave-currents, by passive resistance, moored in its locally disturbed bed; but against the more widely-spread motion caused by wave and tide combined more active resistance is necessary.

Cardium echinatum owes its safety to its powers of burrowing and to its spines, which, curved in the direction of its tubes, offer the least resistance to the cockle's penetration of the sand, and the greatest resistance to its dislodgment therefrom. When pitted against wave-currents the spines are of use to their owner, but when pitted against wave and tide together they must be prejudicial, as, notwithstanding their curvature, they cannot fail to offer great resistance to the animal in burrowing. Similarly, a shell of globular form will serve the purpose of a mollusk that relies on its powers of maintaining a fixed position, whereas a shell of a more compressed form will be better suited to one that depends for safety on its power of penetration. When the fry of such a variable species as *C. echinatum* is spread in countless millions over an area affected by wave-currents, it is reasonable to

suppose that the varieties best suited to the bottom and locality will survive. The same may be said in the case of the fry being spread over an area affected by wave- and tidal currents combined. In this way different varieties will be localized in different places.

As an example of the difference in relative compression of different specimens of *C. echinatum*, I may instance two individuals from the English Channel and one from Torbay. The thickness in each case was 1·75 inch, and the length of the Channel specimens 2·175 and 2·4 inches respectively, and that of the Torbay specimen 2·1 inches. These examples were selected (out of a small number of specimens) owing to their uniform thickness making them convenient for comparison. There is no reason to suppose they are extreme cases of variation. The difference in penetrative power in these specimens due to difference in form would be considerable.

The genus *Cardium* may again serve to illustrate the influence of wave-currents on the local extinction of species.

In Torbay the most abundant cockles are *C. aculeatum* and *C. tuberculatum*, the former having very long spines, the latter having them quite rudimentary. These two species do not apparently thrive together (when their shells are perfect) in the same deposit in Torbay, though their habitats are not far apart, the one being soft and muddy sand, the other pure and firm sand. There can be little doubt that a radical change in the character of the two deposits in which these species respectively live would cause their local extinction, by making it impossible for them to offer a successful resistance to their enemies, the wave-currents. Whilst the two species referred to are locally abundant in Torbay, *Cardium echinatum*, the species most abundant, as a rule, on the British coasts, and whose spines are of an intermediate length, is much less common; for though often abundant in the earlier stages of growth, even undersized specimens are rare compared with *C. aculeatum* and *C. tuberculatum*. Neither the very soft nor the very hard sand seems to suit it.

In past ages, as evidenced by the raised beach on the islet known as the Thatcher, the dominant cockles of the locality were neither *C. aculeatum* nor *C. tuberculatum*, but *C. echinatum* and *C. edule*. There is plenty of geological evidence that in those days the sandstone cliffs were far more extensive than now, and the supply of sand, in consequence, more abundant; and we

seem to have a case in point of the prevalence of particular species of shells being influenced by wave-currents acting on sea-bottoms that do not remain constant in constitution and character.

Preliminary Account of the Development of the Lesser Weever-Fish, *Trachinus vipera*. By George Brook, F.L.S.

(Read 1st May, 1884.)

[Plates III.-VI.]

The observations on which my paper is based have been made on eggs laid in my aquarium by fish which I have had in the tanks over two years. The conditions under which the development was carried on will not therefore be normal, and the direct rays of the sun were never allowed to fall on the eggs, as would be the case in nature.

The eggs of *Trachinus vipera* are laid in the summer. I have had them as early as April, both last year and this, as floating eggs. Dead eggs have been found at the bottom of the tanks in March. The eggs found in April were very few, and often not fertilized. It was not till the 6th of June that they began to show in any numbers, and with but a small proportion of unfertilized ones. They continued to be laid at intervals of three or four days during June and July; but the batches laid during the last few days of July were again few in number, and with a large proportion of unfertilized ova amongst them; and no ova were found in August at all.

The egg of *Trachinus vipera* is about 1·32 millim. in diameter, of a beautiful pearly white, and quite translucent, and contains from 20 to 30 small oil-globules which cause it to float on the surface of the water. These oil-globules are scattered over the upper hemisphere of the yolk, and lie between it and the vitelline membrane. They vary in size from ·12 to ·03 millim. The oil-globules cause the egg to float with the germinal disk downwards, so that the embryo is developed on its back, so to speak, and it is not until some time after hatching that the young fish is enabled to swim with the ventral surface downwards.

Eggs freshly extruded from the ovary are not spherical, as the egg-membranes are larger than the yolk, and appear wrinkled until the "breathing-cavity" gets filled with water, and it is

then that the egg rises to the surface. Although the number and size of the oil-globules is variable, this is only within certain limits; and I have never found an egg of *Trachinus* with only one large oil-globule, as appears to be the rule with the majority of other species of pelagic eggs hitherto described.

The eggs are laid in the night; but at what time I am not certain. We have watched the fish up to 1 A.M., and resumed watch again as early as 5 A.M., but have never been able to catch them in the act of ovipositing. They are probably laid in the very early hours of the morning, just before or after daybreak, as we always found them well advanced in the segmentation stage by even 5 A.M. I have this year, however, had an opportunity of studying the segmentation process from its commencement, in a few eggs laid in the beginning of April and at a temperature 9 or 10 degrees lower than at their normal time of appearing last year, and consequently considerably retarded in development. The eggs, being at the surface of the water, are naturally more affected by the temperature than would be the case otherwise; so that in order to estimate fairly the rate of development the temperature of both room and water must be taken into account. The temperature of the water in my aquarium varied during the months of June and July from 54 to 58 and 60, and that of the room from 54 to 62, and during the last two days it went up to 65.

A comparison of the various times at which the embryo developed certain organs or structures made in various batches of eggs at various temperatures, showed that a difference of about 2 degrees would retard or accelerate from 9 to 12 hours in the early stages, and a whole day for hatching. I propose, however, to leave the consideration of this part of my subject to a future paper.

Egg-Membranes.—In the fertilized floating ovum the following investing membranes can be distinguished:—

(1) An exceedingly thin membrane showing only as a fine line under the 1-inch objective, hyaline and apparently structureless and non-perforate. This is the *vitelline membrane* according to the definition of Balfour.

(2) Within this, and occasionally separated from it by a space. is a much thicker membrane, the *zona radiata*; but I have made no observations on its structure. This is separated from the yolk by a space, the "breathing-chamber" of Ransom, which is only small in the species under discussion. Ryder describes only

one membrane (the *zona radiata*) in the Spanish Mackerel, as also Messrs. Kingsley and Conn in the Cunner. The outer membrane may indeed be only an outer layer of the *zona radiata*; but it is easily separated and made prominent by the use of reagents. Balfour ('Comp. Embryol.' i. p. 50) says that "in osseous fishes the vitelline membrane is usually either absent, or may perhaps in some instances, *e. g.* in the Perch, be imperfectly represented. In the ripe ovum of the Herring there is a distinctly developed membrane exterior to the *zona radiata*, which is probably the vitelline membrane." A vitelline membrane does not, however, appear to have been usually recognized in pelagic teleostean eggs.

The oil-globules scattered over the upper hemisphere are situated inwardly to the *zona radiata*, and sink into little pockets pushed into the yolk from its surface. These two membranes may also be distinctly seen in the unfertilized egg ready for extrusion taken from the body of the fish; but they are then in a relaxed and shrivelled condition. After the closure of the blastoderm at the caudal end of the embryo, the yolk becomes invested by another membrane, which is termed by Ryder the "epiblastic sac," the origin and development of which will be discussed in its proper place.

The *zona radiata* appears to become thinner as development proceeds.

Micropyle.—I have several times seen the circular micropyle opening in the *zona radiata*. It seems to be surrounded by a depression on the outer surface of that membrane, causing a slight protuberance on the inner surface.

Sect. 1. *Segmentation Stage to Formation of Blastodermic Rim.*

9 A.M. In the newly laid ovum the germinal disk is not distinguishable until the first furrow begins to form, faint at first, then forked at each end (fig. 1); and the forking may be seen gradually creeping round until the first two cells are formed, as shown in fig. 2. This takes about an hour to accomplish; and the first furrow is then very thick and distinct, the outline of the cells gradually shading off as it recedes from the furrow until on the opposite side it is only barely visible. Somewhat later this outline becomes more sharply defined. When first formed the two cells of the disk are about ·35 millim. in diameter each; but these increase in size to ·41 millim. before any further subdivision

takes place. The nuclei in the first two cells could not be distinctly made out; but at about 11.15 A.M. a second furrow (fig. 3) began to appear at right angles to the first. Each furrow begins in the centre and extends outwards, deepening more rapidly at its origin, so that the furrow is complete at the inner margin of the cell before it has reached the outer (fig. 5). When the furrow reaches (about 11.45 A.M.) the outer margin, the latter becomes indented, and the four-celled stage is then fully marked out as shown in fig. 4; and two minutes later nuclei appear, but are only faintly visible in this stage. At 12.50 P.M. the nuclei had completely disappeared, and the blastodisk had become almost square. At 1.10 the segmentation-furrows were beginning to form in the same general direction as the first furrow, but somewhat at an angle with it (fig. 5). At 1.35 the eight-celled stage was completed, as in fig. 6, with the nuclei again visible. By 2.30 the nuclei had again completely disappeared; and at 2.40 new furrows made their appearance at right angles to the previous (fig. 6). At 2.55 the sixteen-cell stage was complete, but the nuclei did not appear until ten minutes later, and in this stage are very distinct (fig. 7). The nuclei had again disappeared at 3.35; and from this time the segmentation is not quite regular. The first cells to divide are the two centre ones on each side, next the corner cells, and afterwards the four central cells; but the whole process only occupies 15 to 20 minutes, and this time the four central cells no longer divide vertically, but in a horizontal plane so as to form two layers. From this point it is difficult to follow the process of segmentation, the outlines of the cells being too confused through overlapping. The disk is now almost circular, and has a diameter of about ·73 millim. Two hours later segmentation had progressed rapidly, particularly in the centre, where the cells were at least four rows deep. About this time free nuclei make their appearance in the "nuclear zone," and free cell-formation takes place. In two hours' time a first row of these free cells has been formed round the disk, and there are a few isolated cells of a second row (fig. 8). A little later a partial side view of the egg showed that the cells of the "nuclear zone" had pushed their way partly under the outer edge of the blastodisk. Three hours later it is found that segmentation has proceeded; but there is still no increase in the diameter of the blastodisk, which is now quite circular. The disk has now the appearance presented in fig. 9. There are three

rows of nuclei around the disk; but the outline of cells cannot be made out. These nuclei in the majority of ova are fairly uniformly distributed, though not with the geometric precision of Kupffer's figure ("Beobacht. ü. d. Entw. d. Knochenfische," Schultze's Archiv, Bd. iv. Taf. xvi. fig. 1). Later on considerable irregularity begins to show itself, which will be referred to in its proper place. The blastodisk at this stage is almost flat on the under surface, or perhaps very slightly convex, and has perceptibly increased in thickness at the centre. There is no material change in the blastodisk 12 hours later; the "nuclear zone," however, has altered considerably. The zone has increased in width, the nuclei (which are very distinct) have increased considerably in number, and are now most irregular in their arrangement; so much so that it is impossible to distinguish a series. The majority of nuclei are in pairs; but here and there are clusters of three and four, in some cases four arranged in a chain. This is possibly a consequence of the subdivision of the nuclei. About 30 hours after the first furrow is formed the blastodisk begins to extend over the yolk; it also becomes thinner at the centre, and is now concave on the under surface. No trace of the segmentation-cavity is yet to be found, nor does there appear to be that stratification in the cells which, as described by Messrs. Kingsley and Conn, is the case in the embryo of the Cunner. About 4½ hours later the first beginning was noticed of the rim which ultimately forms the boundary of the segmentation-cavity. It showed itself on a surface view of the underside of the blastodisk as a short line rising a little within its margin, this line gradually extending itself parallel with the blastodisk margin in each direction until about 3 hours later the outline was sharply and definitely marked out all round. The blastodermic ring thus formed is a little broader at one point whence the future embryo will develop (fig. 10). Diameter at this stage ·88 millim. No separation of the subjacent cells from the blastodisk to form the segmentation-cavity has yet taken place, and its origin will be considered in the next section.

The so-called invagination of the hypoblast is very clearly made out, in optical section, as at first a single layer of cells sharply defined in the upper and lower limits of layer (fig. 11). The origin of this layer in teleostean fishes is not clearly understood. According to most recent investigations, Henneguy (Comptes Rendus, xcv. 1882, pp. 1297–1299) maintains that this

invaginated hypoblast arises in the Trout by an involution of the nervous layer of the epiblast, and that the epidermic layer ends on the surface of the yolk, taking no part in the process. On the other hand, Messrs. Kingsley and Conn maintain that in the Cunner the "epidermic layer" only of the epiblast takes part in the invagination. According to Balfour, in smaller teleostean eggs the nucleated cells of the intermediary layer form the hypoblast. Without the aid of sections it is impossible to tell positively what really does take place; and the difficulty of preserving and hardening pelagic eggs in this stage is well known. I am, however, inclined to think that Henneguy is right, and that the invagination observed in optic section in the living egg is an inward folding of the lower layer cells of the epiblast. The cells thus formed are, to begin with, in a single layer only, the outline of which, top and bottom, is very well marked, but the cells themselves are not columnar as described by Kingsley.

Intermediary Layer=Parablast of Klein.—My observations confirm Van Bambeke's and Klein's figures and descriptions as regards the presence of a thickened peripheral layer or welt, the "nuclear zone" of Kupffer. This thins off under the blastodisk, and also gradually becomes indistinguishable as it passes away from the blastodisk round the yolk. Very early in the segmentation of the disk, certainly as early as the eight-cell stage, and probably earlier, there is visible around the disk a granular zone, the largest granules being nearest to the disk, and becoming finer and finer further away. This is a prominent zone in the sixteen-cell stage (fig. 7), and it is in this zone that the free cell-formation already described takes place. A cellular structure has certainly been traced under the rim of the blastoderm, but not far, probably only so far as the thickened portion of the blastodermic rim extends. There is, however, nothing in the intermediary layer under the disk corresponding to the median lens (*lentille*) described by Van Beneden.

Retardation of this Stage.—The development described up to the present was observed in April at a mean temperature of 49° F.; whereas the later stages were observed in July at a mean temperature of 60° F. Thus the rate of development in this section is altogether out of proportion to the remainder; but I have had to avail myself of these earlier observations, because in the hot summer weather the eggs laid during the night were well advanced in the segmentation stage by 7 A.M.; and thus I

have no record of the early segmentation at higher temperatures. The difference is somewhat as follows:—Whereas at 49° F. it took 2½ days for an egg to advance from stage of fig. 9 to that of fig. 12, at 60° F. this was accomplished in 22 hours.

Sect. 2. *From the first Formation of the Embryo to the Closure of the Blastopore.*

The embryonic area encroaches considerably further on the segmentation-cavity than is shown in fig. 10 before the first traces of the embryo make their appearance. Shortly before this takes place semidetached and quite detached cells make their appearance about the apex of the embryonal shield. These cells rarely have a rounded shape, but are mostly more or less angular, and often have a pointed prolongation. These detached cells, so far as I could make out, are lying loose on the floor of the segmentation-cavity. This, however, is here so shallow that they appear to fill up the whole area in an "optical section," and cannot be made out clearly in this way. Can these be cells pushed up from the intermediary layer to take part in the formation of the alimentary tract, as suggested by Kingsley is the ultimate purpose of the intermediary layer? or are they detached cells from the invaginated hypoblast or lower layer cells? As the embryonic shield encroaches on the segmentation-cavity, the latter becomes shallower as well, until after the embryo forms and the blastoderm extends still further it becomes, as at first, a mere fissure of separation between the blastoderm and the intermediary layer. Ryder ('Bull. U.S. Fish. Comm.' i. p. 147), quoting from an earlier paper in 'Forest and Stream,' asserts that the segmentation-cavity does not disappear at a very early stage of embryonic life, as Balfour and others supposed, but that it "is filled with fluid, and grows with the growth of the germinal disk, as the latter becomes converted into the blastoderm, and does not disappear until some time after the embryo has left the egg as a young fish, after remaining as a space around the yelk-sac as long as a vestige of the latter remains." My observations appear to confirm the view taken by Ryder. An optical section made after the blastoderm has already crossed the equator of the egg is given in fig. 14, where it will be seen a double line runs forward from the head end of the embryo to the thickened rim, enclosing a cavity which Ryder says is filled with fluid. This double line, with its enclosed cavity, follows the course of the blastodermic

rim as it extends over the yolk, until the latter is completely enclosed. The application of reagents, by bringing about a shrinking of the yolk, causes the outer membrane to separate further from the inner or intermediary layer which remains attached to the yolk. This shows that a fissure still exists between the two layers; indeed it can be traced all through the embryonic life so long as the yolk-sac persists. The distance between the two membranes of this cavity becomes more pronounced in the newly hatched embryo (fig. 27). I have also, as shown in fig. 14, traced a prolongation of the segmentation-cavity beneath the fore part of the head; but have not satisfied myself that it is pushed forward to form the pericardiac cavity, as is maintained by Ryder; although later stages seem to support this view. If the cavity really does extend so far, the line formed by its two membranes under the hind portion of the head is so minute in the living egg as to look single only. In the newly hatched embryo, however, part of the yolk has been absorbed, and the heart then shows clearly in the same cavity as is continued around the yolk.

Kingsley and Conn, in the text of their paper, combat Ryder's views on this point altogether, but add, in a footnote, that later studies make them more inclined to accept them, at any rate partially.

The first step towards the formation of the embryo is the appearance of a faint streak, the keel, in the median line of the anterior portion of the embryonal shield. This keel lengthens, and becomes club-shaped as the embryonal area encroaches on the segmentation-cavity. As the development advances, the anterior portion of the keel is seen to widen, and the outline becomes spathulate. This is caused by outgrowths springing from the keel, one on each side, to form the optic lobes. At first these only appear as slight swellings, but soon a curved line makes its appearance on each side, marking the angle formed by the optic lobes with the keel. By this time the growing blastoderm has already passed the equator of the egg. The optic lobes begin to be segmented off before the protovertebræ form, and the process is completed about the time four or five protovertebræ are visible. The lumen begins to show before eight protovertebræ are formed, and before the blastodermic ring has closed.

The division of the fore part of the medullary cord into fore,

mid and hind brain shows itself before the optic lobes are segmented off, and is well marked at the stage of four or five protovertebræ. The fore brain seems to be marked off from the posterior portion first, then the posterior portion is afterwards divided into mid and hind brain. About the time that the optic lobes are fully segmented off, a lumen appears in the mid brain and almost simultaneously one in the fore brain also, while that in the hind brain develops more slowly, not appearing till 8 protovertebræ are formed, or even later.

The exact time at which the notochord appears was not noted, but it was already a well-marked feature by the time the optic lobes were outwardly marked out from the keel, when it is to be seen extending well up to the eye-lobes. Posteriorly it widens out, and its cells seem to merge insensibly with those of the surrounding tissue; at least, I have not been able to trace it quite up to the edge of the blastoderm.

Kingsley and Conn state that the notochord originates in the hypoblast, that it is then pushed up through the mesoblast, dividing the latter into two lateral plates. I have not been able to verify this statement up to the present. When first observed, the notochord appeared rather flattened in transverse section, and the lateral mesoblastic plates quite distinct.

With the separation of the optic lobes, the two tracts of mesoblast begin to be divided into somites. The first traces of protovertebræ were observed after about sixty hours' development, and after the formation of Kupffer's vesicle.

The thickening of the epiblast forming an invagination for the eye-lens has been observed as early as in embryos with three protovertebræ, but more generally when the embryo possesses about six protovertebræ. My observations of its further development and the separation of the lens were but a confirmation of what is already known on the subject.

It was difficult to make out the auditory vesicles during the process of invagination, and one only began to recognize them clearly by the time the process was completed. Invagination seems to begin, however, very soon after that for the optic lenses, and they are fully marked off, as shown in fig. 19, by about the stage of eight protovertebræ. The lenticular body has an amber tint. About the time that the eye-lenses first show traces of invagination, a broadening out of the tissue on each side of the hind brain is seen to begin; the embryonic border (Embryonal-

saum of Kupffer), which lies outside this, again widens also, and often assumes a pointed form. Probably this widening is the result of the invagination to form the auditory sacs; but I could not make out clearly what was going on until the process was completed. The nasal pits appear also to originate about this time.

Kupffer's vesicle (postanal vesicle of Balfour) appears shortly after the optic lobes are formed, soon after the growing blastoderm has passed the equator of the egg, and therefore a considerable time before the closure of the blastopore. I have not been able to detect the slightest relation between it and this closure, although it certainly increases rapidly in size at the period when the rim is nearly closed, and attains its maximum development soon after the closure. It arises before any protovertebræ are formed, and at the time of its disappearance there are seventeen or eighteen somites. Its proximate origin is signalized, as Kingsley and Conn state, by the appearance of a few granules which draw together, and shortly afterwards the vesicle is seen on optical transverse section as a very flattened lenticular body, amber-tinted, and which, at its first appearance, seems solid. Kingsley states that Kupffer's vesicle arises in the Cunner when the blastoderm has covered over three quarters of the yolk, and after many protovertebræ have been formed. This is consequently at a much later stage in *Trachinus*. Ryder has, in different species, noticed the first appearance of this vesicle at periods varying from the time when the blastoderm covers three quarters of the yolk up to nearly when the closure of the blastopore takes place. In the Trout it appears when the blastoderm has just passed the equator, and in the Perch it does not appear until after the closure of the blastopore.

About, or shortly after, the formation of protovertebræ, free pigment-spots make their appearance, scattered irregularly over the embryo. These increase in number and size until, at about the time the heart begins to pulsate, they assume a stellate form. They do not seem, however, to develop exactly *pari passu* with the embryo; at times they are slightly accelerated or retarded. The assumption of the stellate form may also be either before or after the heart begins to pulsate. Kingsley found that in the Cunner they arise at the same time as the protovertebræ.

The expanding blastoderm continues to grow over the yolk, until gradually it leaves a mere pore enclosed by the thickened

rim of the blastoderm, the axis of the embryo terminating posteriorly on its anterior edge. This pore is ultimately seen to close up, or at least apparently, and nothing left but a thickened patch. This blastodermic pad is, as may be seen from the account of its formation, composed of all that remains of the thickened rim of the blastoderm after it has encircled the yolk, and will, as pointed out by Kupffer, His, and Ryder, enter largely into the formation of the tail, which we shall presently see sprout out in continuation with the axis of the embryo. As Ryder points out, this blastodermic pad may be considered a true tail-swelling. At the time of closure of the blastopore nine or ten protovertebræ are formed, and the tail end of the embryo is somewhat spathulate in shape. The widened part includes the notochord, with an unsegmented plate of mesoblast on each side. It is still impossible to trace the notochord to the extreme posterior edge of the embryo.

We have now brought our consideration of the development of the embryo up to a stage when there are nine or ten protovertebræ. The invagination of the eye-lenses has progressed but slowly. The auditory vesicles, however, have been fully closed in, and the nasal pits are formed. The brain is now divided into the three embryonic regions, and a lumen has appeared in all three, although one does not show itself in the spinal cord until later.

The optic bulbs have become fully differentiated and the lumen has appeared.

Kupffer's vesicle has nearly reached its maximum development and the pigment-spots are well established.

Sect. 3. *From Closure of the Blastopore to the Pulsation of the Heart.*

The first important developments after the closure of the blastopore are the formation of the heart and of the alimentary canal, and both seem to arise at the same time, on the closure of the pore or immediately after it. The heart begins as a small patch often distinguishable by its light amber colour. The patch is situated a little to the right of the central line of the embryo, as seen ventrally, and almost beneath the hind brain, and was most readily noticed on a side view. It has been found as early as the stage when eight protovertebræ are formed (the blastopore being closed), but is usually first distinguishable at a stage when there

are eleven or twelve protovertebræ. In the side view it is seen as a thickening beneath the embryo (see fig. 20). I found it difficult to get a clear view of the changes taking place in this patch in the living egg, and can add nothing from this point of view to its development. Many of the cells are, however, so far as I can make out, budded off from the mesoblastic roof of the cardiac cavity, just as Ryder describes, and then grow down and come in contact with the floor of the cavity. Messrs. Kingsley and Conn observed the same process of development in the Cunner. The heart is solid at first, but a lumen afterwards develops when it has reached the floor of the pericardiac space. The heart is only a simple hollow cellular tube at the time it commences pulsating, and has its broad venous end closely applied to the vitellus. The first pulsations, faint and somewhat intermittent, were observed at the stage of about twenty protovertebræ, and about the same time the first spontaneous movements of the embryo have been noticed. The venous end of the heart is somewhat funnel-shaped, and remains applied to the vitellus up to the time of hatching. No blood-corpuscles nor circulation is visible up to three or four days after hatching. The observations of Ryder and Kingsley and Conn seem to agree with my own on this point—no vascular system has been found up to a considerable time after hatching. Ryder found that in the Spanish Mackerel the aorta only begins to develop 16–20 hours after hatching, the whole development up to hatching only occupying 24 hours. I therefore conclude that I have not been able to keep my embryos long enough to follow the development of the vascular system. This seems in strange contrast with observations on non-pelagic eggs, which usually show a very marked circulation, both in the embryo and around the vitellus, a considerable time before hatching.

Intestine.—On the closure of the blastopore, and when Kupffer's vesicle is at its maximum development, a thin layer of granules extends from the vesicle to the blastopore, which is either the homologue of the postanal gut or of the neurenteric canal. If Balfour is correct in identifying Kupffer's vesicle with postanal vesicle of Elasmobranchs, this layer of granules should represent the first formation of the neurenteric canal, and the anus should be formed at a point anterior to the vesicle. The mesenteron is, however, developed from the granular band forwards, and after

Kupffer's vesicle has atrophied the anus seems to be formed pretty nearly at the same point; but I have not been able to make out clearly the relationship between Kupffer's vesicle and the mesenteron.

General advance.—At the time of closure of the blastopore the brain was already marked out into its three regions, and a lumen had developed in them. Shortly afterwards a lumen is seen extending through the whole length of the cerebro-spinal cord, and before the heart has begun to pulsate the hind brain has been further differentiated, in that the cerebellum has been fully separated off from the medulla oblongata. The nasal pits are now large and well defined. The inner lens of the auditory capsule has increased in size, become hollow, and simultaneously with the pulsation of the heart the otoliths make their appearance. The lenses have become fully separated from the optic bulbs. The pigment-spots have assumed a stellate form. The first rudiments of lobes to form pectoral fins may be found just before the heart begins to pulsate. Generally also the tail has commenced its growth, and the first folding of the epiblast to form the caudal fin is an accompanying phenomenon.

Sect. 4. *From the Pulsation of the Heart to the time of Hatching.*

Liver and Pancreas.—As the mesenteron increases in size a lumen arises throughout its course and extends quite into the head. At the beginning of the sixth day of development a ventral swelling makes its appearance in that part of the mesenteron lying between the rudimentary pectoral fins—the first rudiment of the liver. This becomes more marked as the tail curves round the yolk, and about the end of the seventh or beginning of the eighth day, the liver presents a lobulated character. Before this time, however, another organ, the *pancreas* (fig. 23), makes its appearance on the dorsal side of the intestine, and slightly posterior to the origin of the liver. It appears soon after the liver arises, and towards the end of the sixth day, as a pocket pushed out from the mesenteron. The mesenteron, up to period of outgrowth of the liver and pancreas, was straight, but increasing size of these two organs, as well as of the mesenteron itself, causes the canal to take an S-shaped form, and this becomes still more involved as development proceeds.

The *proctodeum* seems to arise rather late in development. I

have not been able to trace it through all its phases. A strand of cells extends from the point where the future anus will open, upwards and inwards to meet the mesenteron, and the proctodeum is probably invaginated along this short strand of cells, but no lumen is formed up to at least four days after hatching. The constriction in the alimentary canal which is shown in figs. 27 & 29 is not, as might be at first supposed, evidence of the junction of the proctodeum and the mesenteron. It is in reality a fold in the mesenteron itself produced by a bending down of its apex in consequence of the development of the embryo, and is more marked in some individuals than in others. It perhaps may be said to mark off the cloacal part of the mesenteron. The mesenteron, which has widened out up to the point where the liver arises, suddenly narrows, as seen in side view, and extends as a comparatively narrow tube into the region of the head. The changes which take place in the respiratory section of the mesenteron are exceedingly difficult to follow in the living embryo, owing to its being curled up within the shell, and I propose to leave a discussion of this portion until I have made an investigation of stained specimens and sections.

The invagination of the stomodeum does not seem to take place until after the embryo has left the shell. Three pairs of branchial clefts were observed on the eighth day. The first pair, the *hyomandibular*, is developed about the time the heart begins to pulsate.

The heart has the simple form shown in fig. 21 when pulsation first begins, and the lumen is not very well marked. Its wider part indicates where the future venous end will be. Its development and separation of a ventricle will best be understood by a comparison of figs. 19–26.

The eyeballs begin to be pigmented some hours before the first specimens of a batch are hatched, and those which are hatched out later have them fully and darkly pigmented before leaving the egg.

After the blastopore has closed, the tail is developed as a *free* prolongation of the vertebral column; and as soon as it has fairly left the yolk, the first folding of the epiblast to form the continuous embryonal dorsal and ventral fin is to be seen. After the pulsation of the heart begins, the development of the tail is more rapid, and its gradual extension over the yolk will be easily followed by a comparison of the accompanying figures, up to the

point where the apex is hidden in ordinary views behind the head.

The areas where the embryonal pectoral fins are to develop are at first granular patches situated on each side about the level where the diverticulum of the liver arises. Within the area of each patch, a little later, a longitudinal ridge-like thickening of the epiblast is pushed out, which gradually extends into a fin. The ventral fins are formed in a similar manner somewhat later. The position of these fins, at first parallel to the notochord, afterwards at a considerable angle to it, will best be seen from the figures. After hatching, the bases of both pairs of fins are drawn down ventrally, and as the yolk-sac becomes absorbed, the fins lie closer to the body.

No detailed observations have been made on the development of the excretory organs and genital ducts. The vesicle near the anus which develops into the urinary bladder (*u.v.*) was first noticed on the seventh day. Its appearance at time of hatching is shown in fig. 27, with the commencement of the *Wolffian duct* (*w.d.*) leading from it.

The young fish generally begin to hatch out on the tenth day; somewhat accelerated individuals and batches on the ninth, and slightly retarded ones not till the eleventh day. Young fish of the same batch would continue to hatch out at intervals for two or three days afterwards. The young fish, for some hours after hatching, lies on its side, or more often quite on its back, but begins to right itself as the large yolk-sac is absorbed. The length of the newly hatched embryo is 3·5 millim. The mouth, which is only indicated by a slight depression in the newly hatched embryo, is well formed, and the jaws have a slight motion 24 hours afterwards, and by this time also the yolk-sac has become entirely absorbed.

Although I have been able to keep some specimens a week after hatching, further development was slight and probably abnormal, as I never succeeded in feeding any of the young fish.

Summary.

The egg of *Trachinus* is about 1·32 millim. in diameter, and contains from 20 to 30 small oil-globules, thus differing from the majority of floating fish eggs hitherto described.

In the unfertilized egg a vitelline membrane is easily distin-

guishable, but afterwards this comes in close contact with the zona radiata, and often requires the action of reagents to show it properly.

My observations appear to confirm those of Henneguy, that the invagination observed in optic section in the living egg is an inward folding of the lower layer cells of the epiblast, and that afterwards the alimentary tract is built up from this layer, together with material derived from the intermediary layer. This point cannot, however, be settled definitely without a careful examination of sections of this stage.

My observations confirm those of Ryder as to the nature and persistence of the segmentation-cavity, and in this respect pelagic teleostean eggs seem to differ from all others hitherto described.

Although the heart appears early on the fourth day, its venous end remains closely applied to the vitellus up to several days after hatching, and I have not been able to find any vascular system either in the embryo or in the vitellus up to 14 or 15 days after development begins, that is 4 or 5 days after hatching. In this respect the observations of Ryder and Kingsley and Conn agree with my own, although in non-pelagic teleostean eggs an elaborate circulatory system is developed both in the vitellus and in the embryo a considerable time before hatching.

I have nothing new to record in the later stages of development. The liver and the pancreas arise as little pouches budded off from the mesenteron; the proctodeum arises late, but is well formed at the time of hatching. The stomodeum does not appear to develop until the embryo has left the shell. The young fish usually hatch out on the tenth or eleventh day after impregnation, the early ones with little pigment on the eyes and body, the later ones with the pigment much more develcped.

DESCRIPTION OF THE PLATES.

Lettering used throughout Plates.

b. c. = breathing-chamber.
h. = hypoblast.
b. = blastoderm.
s. c. = segmentation cavity.
b. r. = blastodermic rim.
k. = keel.
o. l. = optic lobes.
a. s. = auditory sacs.
k. v. = Kupffer's vesicle.
b. p. = blastopore.
h. = heart.
e. s. = embryonic shield.

g. = oil-globules.
v. = vitelline membrane.
n. z. = "nuclear zone" of Kupffer.
n. = notocord.
p. c. = pericardial sinus.
l. = liver.
z. r. = zona radiata.
y. = yolk.
p.v. = protovertebræ.
p.f. = pectoral fin.
v.f. = ventral fin.
f. b. = fore brain.
m. b. = mid brain.
h. b. = hind brain.
c. = cerebellum.
m. o. = medulla oblongata.
p.g. = pineal gland.
p. s. = pigment-spots.
m. = mesenteron.
p. = pancreas.
n.p. = nasal pit.
o. p. = invagination for eye-lens.
u. v. = urinary vesicle.
w. d. = Wolffian duct.

Figures 1–9, 10, 12, 13, 15, 16, 19, 21–24 are views looking down on egg as floating freely, and, since animal pole is downwards, represent in all cases ventral surface of the blastodisk, embryo, &c., as seen through the transparent intervening yolk-mass. All the sketches are made from the living egg, and changes that might be attributed to death or to effect of reagents are completely excluded.

In Plate III. the darker tint indicates blastodisk proper, and the pale tint shading off the intermediary layer.

In Plate IV. medium tint indicates embryonal shield and structures formed from it, embryo proper being marked by a deeper tint, whilst a light tint washed over whole marks boundary and extension of the growing blastoderm.

In Plates V. and VI. embryo proper and its parts are alone tinted; whilst in fig. 27 extent of yolk-mass is shown by a darker tint.

Plate III.

Fig. 1. Formation of first furrow in the germinal disk. ×26.

2. Appearance when outline of first two cells is formed. ×26.

2*a*. Transverse section of above, showing that the first furrow penetrates the whole thickness of the germinal disk. ×26.

3. First formation of the second furrow at right angles to the first. ×26.

4. Completion of the four-cell stage with nuclei. ×26.

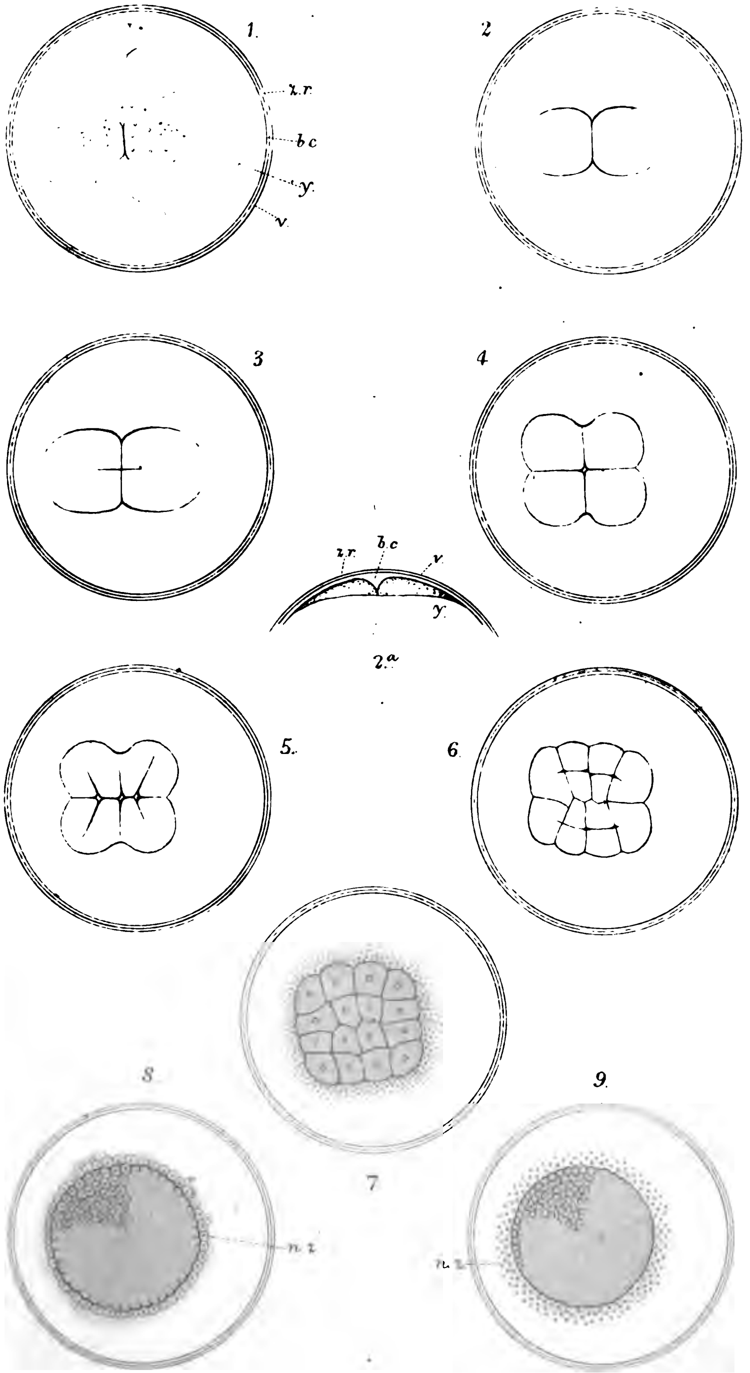
5. Direction of the furrows which divide the four cells into eight. ×26.

6. Eight-cell stage after the nuclei have disappeared and the furrows commenced which divide the disk into sixteen cells. ×26.

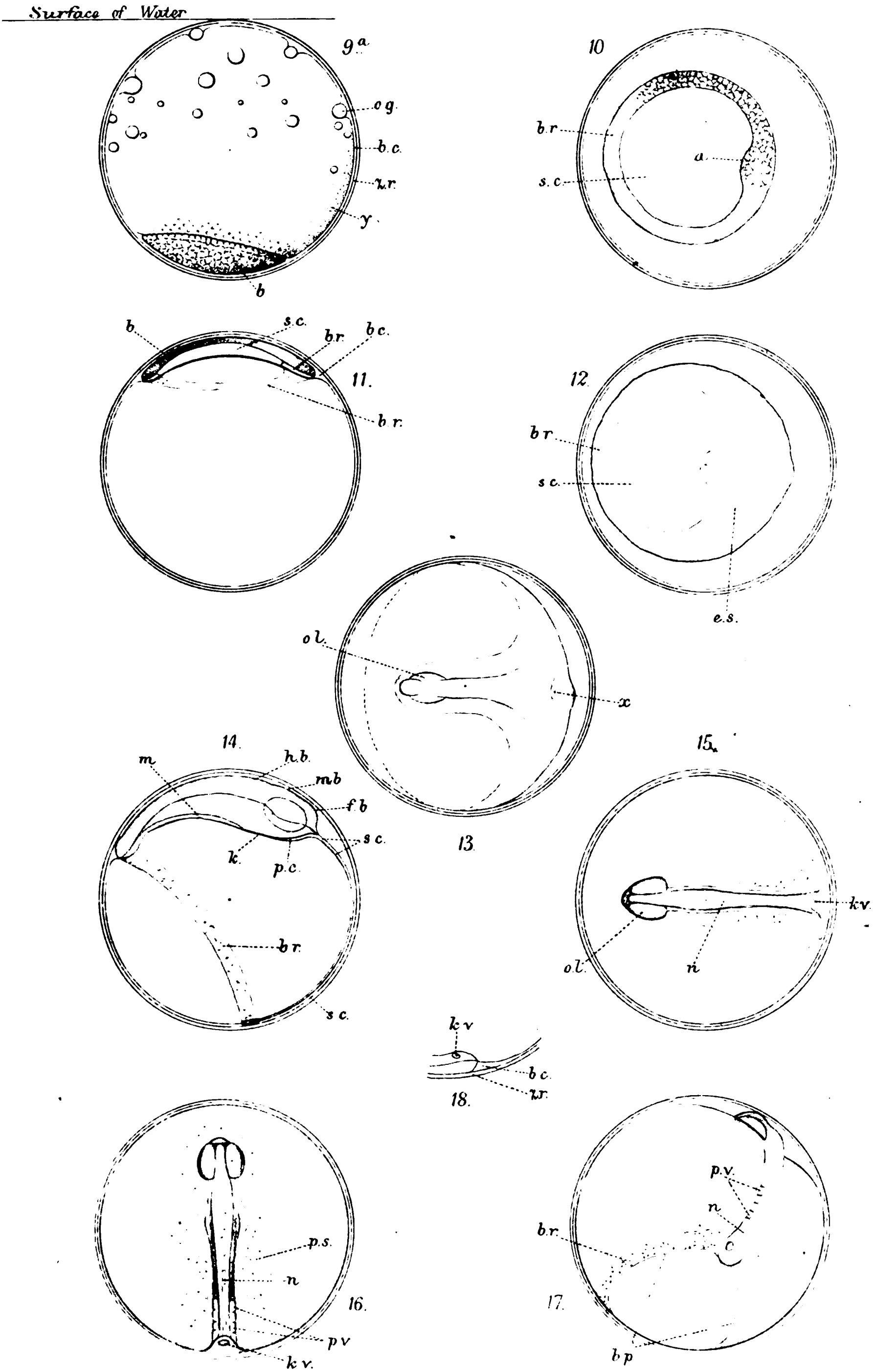
7. Sixteen-cell stage, complete with nuclei. Outside the disk will be observed the collection of granules and free nuclei, in which the intermediary layer is developed. ×26.

8. Later segmentation-stage, in which the blastoderm consists of more than one layer of cells, and around the disk will be seen the first row of the intermediary layer cells formed by free cell-formation. ×26.

9. A little later stage, in which three rows of cells have been formed in the intermediary layer; but the outlines of the cells are not distinguishable, and the nuclei alone remain to mark the position of each cell. ×26.



E. Carter sc. EMBRYOLOGY OF TRACHINUS VIPERA. Mintern Bros imp.



EMBRYOLOGY OF TRACHINUS VIPERA.

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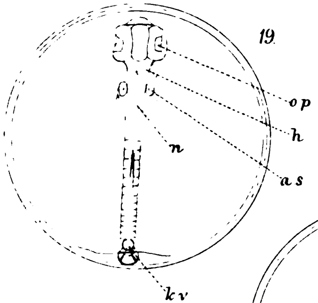

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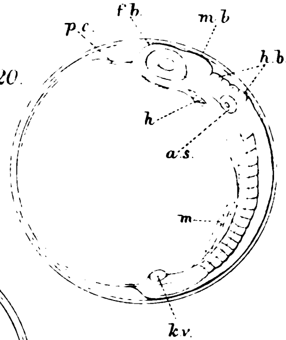

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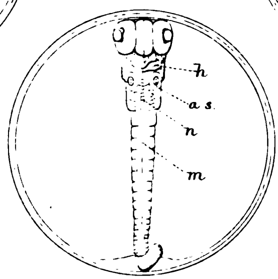

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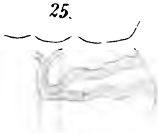

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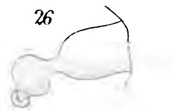

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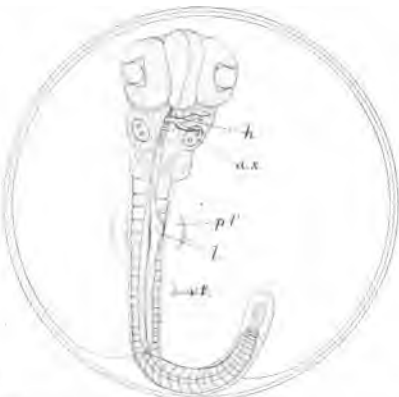

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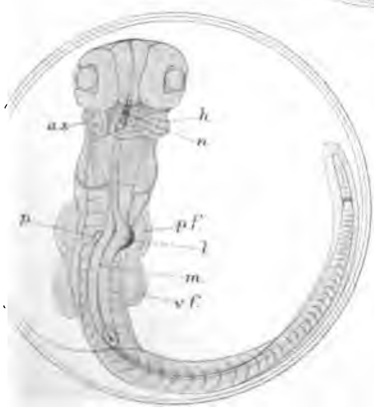

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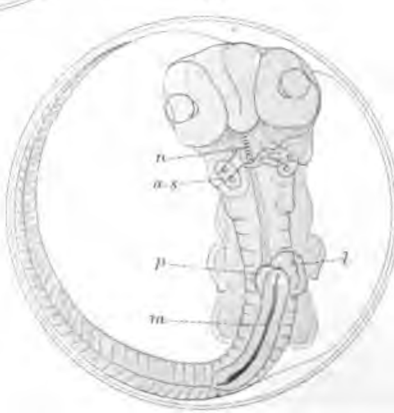

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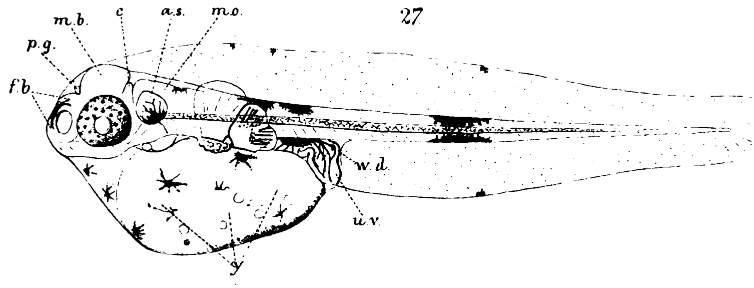

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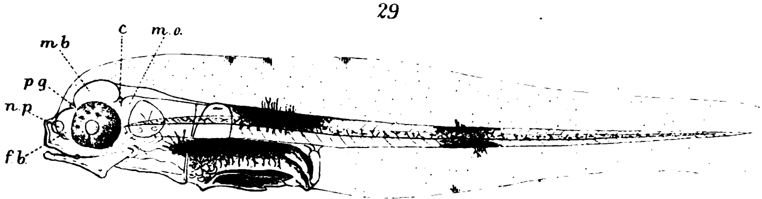

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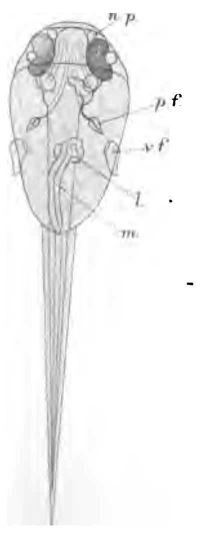
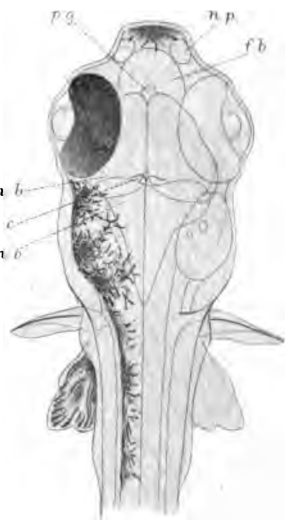


30.



EMBRYOLOGY OF TRACHINUS VIPERA.

PLATE IV.

Fig. 9*a*. Side view of above, as seen floating at the surface of the water. ×26.

10. Early stage of the invagination process, as seen from beneath: (*a*) the hickened part which forms the shield in which the keel is afterwards developed. ×26.
11. Side view of above. ×26.
12. Embryonic shield well advanced, and just before the keel begins to form as a faint longitudinal streak. ×26.
13. Later stage, in which the anterior portion of the embryonic axis is defined, and the thickening for the optic lobes is seen. ×26. (*x*) Posterior end of embryo turned upwards to eye of observer.
14. The blastoderm has here spread more than halfway over the yolk, and with it the segmentation-cavity is carried along. ×26.
15. Embryo of third day, showing thickening where the auditory sacs will be formed. ×26.
16. Embryo later on third day, showing four protovertebræ. ×26.
17. Embryo shortly before closure of blastopore. ×26.
18. Side view of part of fig. 17, showing the position of Kupffer's vesicle. ×26.

PLATE V.

Fig. 19. Embryo of fourth day, showing auditory sacs, heart, and 16 protovertebræ. ×26.

20. Side view of preceding figure. ×26.
21. Embryo of fifth day. ×26.
22. Embryo of sixth day. ×40.
23. Embryo of seventh day. ×40.
24. Embryo of eighth day. ×40.
25. Appearance of the heart on the eighth day.
26. Appearance of the heart on the tenth day.

PLATE VI.

Fig. 27. Newly hatched embryo with pigment-spots accurately marked. ×28.

28. Ventral view of above, showing position of the pectoral and ventral fins, as seen through transparent yolk-sac. ×19.
29. Embryo three days after hatching. ×28.
30. Dorsal view of above, showing change in position of the fins, and the further development of pigment. ×55.

On a new Variety (?) of *Chama*, allied to the *C. arcinella* of Linnæus. By Sylvanus Hanley, F.L.S.

[Read 19th June, 1884.]

Among the many novelties added to my collection from the shells collected by Admiral Belcher, I descried two specimens which I then supposed to be forms of the West-Indian *Chama arcinella*, Linn. Even now, after long observation, I hardly venture to pronounce them distinct.

Yet, whether variety or species, they merit notice; for although the typical form has been frequently and well delineated, I know no other original figure of this abnormal variety (?) since the days of Bonanni, who, in 1684, roughly yet characteristically portrayed it in his 'Recreatio mentis' as from Brazil. It may be designated, then, *C. arcinella*, var. *Bonanni*, or

C. Bonanni.—Testa *Ch. arcinellæ* (Linn.) persimilis, minor autem quamquam plus ponderosa; costæ radiantes nodoso-dentatæ, haud aculeis longis spinosæ, pauciores (circiter 8), latiores: intus purpurea. Long. 1 poll.

Habitat. Brazil? Zanzibar? Mus. Hanley.

Its outline is much blunter and rounder than in the typical form, and its ribs do not exhibit those long spines which form so prominent a feature in that well-known shell. I recognize the long-lost form, so coarsely yet so adequately depicted by Bonanni in his 'Recreatio' (f. 336), copied by Lister (Hist. t. 355. lower f. 192) and Petiver (Pterig. pl. 15. f. 389). These figures were not originally cited by Lamarck himself as identical with the Chemnitzian *C. arcinella* (f. 522–3), but were referred to in the edition by Deshayes.

The colour of both individuals was externally whitish; neither of them displayed the yellow interior so frequent in the larger form; the pustules on the lunule, moreover, seem larger than in the latter, which has usually 12 ribs.

The smaller of my specimens was attached to a worn valve of an *Arca*, that reminds me in its outline of the Peruvian *C. brevifrons*.

I have lately seen a specimen attached to a *Pectunculus* ascribed by Reeve to Zanzibar.

On *Heterolepidotus grandis*, a Fossil Fish from the Lias. By James W. Davis, F.L.S., F.G.S.

[Read 6th November, 1884.]

(Plate VII.)

Genus Heterolepidotus, *Egerton*.

Head large; snout obtusely conical; maxillary and mandibular bones straight; teeth of various sizes, the larger ones strong and bluntly pointed, the smaller ones sharp and numerous; gape wide; pectoral and ventral fins large; dorsal fins remote; scales large, thick, and lustrous, more or less serrated on the posterior margins; abdominal scales small and elongated; tail broad, the upper lobe ridged, with strong fulcral scales. (*Egerton.*)

Heterolepidotus grandis, sp. nov.

The fossil fish which serves as subject for the following description is a remarkable specimen, measuring 40 inches in length. Its bony structure is preserved and well exposed, whilst the scales, which are apparently thin, are preserved only in patches, principally on the anterior dorsal and ventral surfaces of the fish. The head is not well preserved; its component bones are disturbed and dissociated. A mass of iron pyrites envelopes the bones of the vertebral column from its connexion with the head backwards as far as the anal fins, beyond which the vertebræ are well defined.

The particulars following give the size and relative proportions of the fish:—

Length	40	inches.
Depth behind the pectoral fin	8	„
Depth between the dorsal and ventral fins	6	„
Depth at the base of the tail	3·5	„
Diameter between the extremities of the lobes of the tail	10·5	„
Length of the head	8	„
Occiput to dorsal fin	11	„
Base of dorsal fin	5	„
Dorsal fin to base of caudal	10	„
Anterior of pectoral fin to ventral	12	„
Anterior of ventral fin to anal	6	„
Anterior of anal to base of caudal fin	7	„

A comparison of these measurements with those given by Sir Philip Egerton (Memoirs of the Geological Survey, decade xiii. plate 3), in the description of *Heterolepidotus latus*, shows that

the latter was a fish considerably deeper in proportion to its length than the present one; and whilst the form of this specimen was slim and graceful, its fins are longer, more powerfully developed for rapid motion than those of *H. sauroides*, Egert. (*op. cit.* pl. 2). The scales on the dorsal and median surfaces, represented natural size on my Plate VII. fig. 2, are rhomboidal in outline: those on the ventral surface are larger and elongated, gradually becoming still longer as they near the ventral line, where the scales are twice as long as broad. The scales are thin and apparently flexible, which may account for their not being very extensively preserved. They are covered with small pustulations on a thin coating of ganoine. Thus, whilst the scales are similar in form and possess the distinguishing characteristics of the *Heterolepidoti*, as defined by Sir P. Egerton, they differ in being very thin and pustulate. The exposed bones of the cranium are also covered with rugose pustulations on the surface of the ganoine. In some instances the pustules attain ·1 inch in diameter. The remaining bones of the head are more or less smooth or striated. The lower jaws are 5 inches in length, and a number of teeth are scattered about, some of them in small patches, indicating that they were closely aggregated on the surface of the jaws. The teeth are small, about ·1 inch in length, conical and pointed. If the fish had a series of larger teeth, they have entirely disappeared. The external cranial plates are preserved, and the scapulo-coracoid arch supporting the large pectoral fins is strong and powerfully built.

The anterior portion of the vertebral column is unfortunately enveloped in iron pyrites; the posterior part, behind the anal fin to the base of the caudal, consists of about 20 vertebræ; the termination of the column, composed of an additional 9 vertebræ, is deflected so as to enter the upper lobe of the tail, the latter having a decidedly heterocercal form. The lower lobe consists of 16 rays, which are attached to the under surface of the vertebræ by a number of broad, somewhat spatulate and flattened, hæmal spines, expanding so as to form a rounded termination for articulation with a second series of intermediate bones, to which the fin-rays are attached. The latter consist of a series of jointed ossicles; the longest rays are 6·5 inches in length, and repeatedly dichotomize. The lower margin of the tail is furnished with a long series of imbricating fulcral rays. Surrounding, and attached to the caudal vertebræ, of which nine

ascend almost at right angles into the upper lobe of the tail, there are ossicles intermediate between the vertebræ and the fin-rays. They are smaller in size than those of the lower lobe, and extend not only from the ventral but also from the dorsal surface of the vertebræ. The outer fin-rays, springing from the extremity of the vertebral column, are the strongest and attain a length of over 6 inches; about 1·5 inch at the base is solid, the remaining portion being composed of articulations, jointed at very short intervals and divided repeatedly into divaricating branches. The dorsal margin of the fin is strengthened by a series of fulcral rays, much larger and stronger than those of the lower lobe. They spring from the series of ossicles attached to the neural surface of the vertebræ already mentioned, and form a strong support to the long fin-rays extending from the termination of the bony axis of the body. The fulcral ray forming the base of the series is 1·3 inch in length; that portion of it imbedded in the integuments of the fish is divided into five prong-like rootlets, the outermost nearly half an inch apart. The succeeding fulcra are longer and narrower; and beyond these they gradually decrease in size. The whole fin possesses characteristics indicating great power combined with the utmost pliability.

The dorsal and anal fins are supported by strong neural and hæmal spines attached to the vertebræ. Between these and the fin-rays are, respectively, the interneural and interhæmal spines. The interspinous bones supporting the dorsal fin are about 1·5 inch in length, pointed at the lower extremity, the upper one enlarged and rounded, with a cup-like extremity, to form an articulated base of attachment for the fin-rays. The latter are round at the base, fitting to the interspinous bones; the ray for a length of 1·5 inch is undivided; it has a somewhat sigmoidal curvature, and is about ·15 inch in diameter. Between the principal rays are others of the same length but much thinner. Springing from the posterior surface of the base of one ray, they approach, and appear to have been attached to, the upper anterior extremity of the next. The upper extremity of the major fin-rays is enlarged and immediately bifurcates, the bifurcations redividing as in the caudal fin. The subdivisions of the fin-rays are jointed in a similar manner to those of the caudal fin. The dorsal fin is composed of 18 fin-rays besides the smaller intermediate ones, and when perfect would be fully 6 inches in greatest altitude. The anterior margin is strengthened by a series of imbricating

fulcral spines. The anal fin is not well preserved, but sufficient remains to indicate that it was a strongly built and powerful fin.

The ventral fin is situated opposite to the dorsal. It was supported by a large pubic bone, a part of which is preserved attached to the base of the fin. The exact number of rays is not clearly defined. They are strongest on the outer or anterior portion of the fin, and gradually assume smaller proportions backwards. The anterior ray was probably 4·5 inches in length; nearly half the length is unjointed; beyond, it is divided by numerous articulations and becomes rapidly divided into numerous filamentous branches. The anterior margin of the fin is strengthened by numerous imbricating fulcral rays, averaging ·5 inch in length, and extending 3 inches from the base; they are round in section, and being considerably less in diameter than the fin-ray they cluster round it, grouped in a more or less semicircular manner.

The pectoral fin is composed of 24 rays. The anterior ones are 8 inches in length, remarkably strong, and attached by a peculiar articulation to the shoulder-girdle. The anterior rays of this fin are represented, natural size, by the drawing on Plate VII. fig. 3; and a reference to the figure will explain, better than words, the form of the joint. The three anterior rays are attached by a kind of ball-and-socket joint to a projection of the scapular portion of the shoulder-girdle, a second portion of which, or bones in connexion with it, which may be the equivalents of the carpal bones of the bony fishes, descends towards the posterior portion of the fin and supports the remaining fin-rays. The fin-rays are simple and undivided to one third their length from the base, beyond which they are articulated and dichotomize repeatedly. A number of small imbricated rays are attached to the anterior fin-rays; compared, however, with those of the other fins they are small and inconspicuous.

The genus *Heterolepidotus* was instituted by Sir Philip Egerton for the reception of fishes in many respects closely related to *Lepidotus*, Ag., but differing from that genus in their dentition, and more especially in the form and arrangement of the scales of the body. In *Lepidotus* the scales are uniform in size over the whole surface of the body; but in *Heterolepidotus* the scales on the ventral and abdominal surfaces of the body are greatly elongated and much resemble the long and narrow scales

of *Eugnathus* on the same region of its body. The teeth of *Lepidotus* are of two kinds—obtusely pointed and uniform in size in the jaws, or rounded and palatal like those of the Pycnodonts; in the genus now considered the teeth are numerous, pointed, and may vary in size. The specimen described above agrees with Egerton's definition of the genus *Heterolepidotus* in possessing elongated scales on the ventral region of the body and in having sharply pointed teeth, but in this specimen the teeth appear to have been uniform in size, and in this respect it differs from either of the two species described in the 13th decade of the Memoirs of the Geological Survey. The scales also, whilst conforming to the generic requirements, are thin and pustulate and devoid of serrations on their posterior margin, whereas in those already described the scales are thickly coated with ganoine and have the margins serrated. In form this example is more nearly related to the slim *H. sauroides* from Barrow-on-Soar than to the thick-bodied *H. latus* of Lyme Regis. The bony skeleton of the specimen now described is more satisfactorily exhibited than has perhaps previously happened, and it exposes some points of considerable interest; amongst others, the attachment of the dorsal and anal fins, with the series of well-developed interspinous bones, the peculiar arrangement of the articular apparatus of the pectoral fins, and the heterocercal form of the tail. Sir P. Egerton considered that the caudal fin of the *Heterolepidoti* was of strictly homocercal form; but it is evident from this specimen that the fin-rays are wholly supported from the hæmal surface of the spine, and that only the fulcral plates are supported from the neural—an arrangement which is the same as that in the living *Lepidosteus*, though the form of the tail in the latter is externally diphycercal, whilst that now described is deeply forked.

Whilst it is evident that in many particulars the specimen now described does not clearly coincide with the characters of the genus *Heterolepidotus* as defined by Egerton, it is nevertheless undesirable to multiply genera, and it is proposed to include this species in the genus *Heterolepidotus*, with the specific appellation of *grandis*.

The figure of the specimen has been reduced to one third the size of the original by Mr. Henry Sykes, to whom I am much indebted for the careful and admirable manner in which the drawing has been rendered.

Formation and Locality. Lias: Lyme Regis.

DESCRIPTION OF PLATE VII.

Fig. 1. *Heterolepidotus grandis*, Davis, one third nat. size.
Fig. 2. Scales, natural size.
Fig. 3. Anterior fin-ray of the pectoral fin, natural size.

On some Points in the Development of *Motella mustela*, L.

By George Brook, F.L.S.

[Read 6th November, 1884.]

(Plates VIII.–X.)

The eggs of *M. mustela* which I have been enabled to study were deposited in my aquarium during the months of May and June. They belong to the pelagic group of Teleostean eggs, and have usually one large oil-globule which keeps them floating on the surface of the water, although in a few cases I have found a cluster of from two to eight, or even more. These, however, were abnormal forms. Dr. Day, in his 'Fishes of Great Britain and Ireland,' i. p. 315, quotes from the 'Zoologist,' 1879, p. 476, the following words of Cornish:—"The nest wherein the spawn is deposited is invariably formed of the Common Coralline, *Corallina officinalis*, thrust into some cavity or crevice of a rock close to low-water mark." There must surely be some error in this observation, as it is manifestly entirely contrary to the nature of a pelagic egg to be retained in a nest. The eggs of all the other Gadidæ, so far as known, are pelagic, so that there is nothing exceptional in those of *Motella* being so.

The eggs are somewhat oval in shape, and are not all of equal size. The length of the longer axis varies from ·655 millim. to ·731 millim., and that of the shorter axis from ·640 millim. to ·716 millim. The shape, however, seems to vary considerably. Many are almost globular; and the oval shape seems often to be produced by three or four eggs touching one another. The slightest pressure alters the shape of the egg in this species, a feature which I have never observed in the egg of *Trachinus*. In normal eggs the single oil-globule is usually about ·11 millim. in diameter. In those eggs with more than one oil-globule there is usually about the same volume of oil as in the large single globule, but divided into larger or smaller globules, according to the number. A batch of eggs which were laid on the 28th of May had the majority of the eggs with more than one oil-globule,

Scales
Nat. Size

Size.

and curiously enough the eggs of this batch showed more irregularities in the early stages of development than any others that were observed. In any case eggs with a number of oil-globules either developed so irregularly as to die before hatching out, or the small oil-globules gradually coalesced to form one large one before the embryo left the shell. There was no exception to this rule, so that directly or indirectly an abnormal development of the oil-globules has its influence on the development of the embryo.

The earliest stage observed was that in which the disk is divided into sixteen cells. At this time the disk is oval in shape and measures about ·457 millim. by ·381 millim.; but these measurements are only approximate, as the form and size of the disk varies considerably in different eggs. Sometimes in this stage, at others not until the thirty-two cell stage, the disk becomes somewhat square in outline, and then measures ·441 millim. in diameter. The disk is then somewhat concave beneath, and its position is as usual a little eccentric. The disk then, with increasing cell-division, becomes more and more rounded in outline until about five hours after formation of sixteen-cell stage it has the appearance shown in section in fig. 1. Here the epidermal layer of the epiblast is well defined, and the surface of the disk lying on the yolk is perfectly flat.

It is about, or a little earlier than, this stage that the first collections of granules and nuclei are observed to form the *periblast* (Agassiz and Whitman *) =*parablast* of Klein †. In this respect the egg of *Motella* differs considerably from that of *Trachinus*. In the latter a minute collection of granules is to be found around the disk, even in the two-cell stage, that is to say on the completion of the first segmentation-process. These granules increase in size and number with each segmentation-process, until in the sixteen-cell stage they form quite a striking feature of the egg, as shown in plate 3. fig. 7 (Linn. Soc. Journ. Zool. vol. xviii.). In *Motella* no such gradual development occurs; and it is not until the segmenting disk presents the characteristic *morula* appearance that the first granules are observed. Again, in *Trachinus* the first row of cells forming the periblast is always uniform and complete before any cells of the second row are formed; whereas in *Motella* it is quite usual to find parts of a second and third row in their places before the first row is

* Proc. Amer. Acad. Arts and Sciences, xx. (1884).

† Quart. Journ. Micr. Sci. xvi. (1876).

completed. The nuclei in the periblast of *Motella* are also considerably larger in proportion to the size of the cell than is the case in *Trachinus*.

The exact nature of the so-called invagination-process to form the hypoblast was not observed, but an optical section taken when this process was well advanced would seem to confirm my views of the origin of the hypoblast in *Trachinus*. Figure 2 represents a surface view of this stage, and fig. 2 *a* the same as seen in section. My opinion at present is that the cells of the periblast are pushed under the germinal disk until they cover the whole floor of the segmentation-cavity, and that cells absorbed from this layer and free cells from the yolk contribute to a very great extent to build up the invaginated layer, if indeed it is not at first formed entirely from these sources. I have discussed this question more fully in a paper on the "Origin of the Hypoblast" (Quart. Journ. of Micros. Sci. Jan. 1885, p. 29), and it will be useless to renew the discussion here. The cells of the new layer in *Motella* are, however, so much larger than is usual in Teleostean ova that their exact position is easily made out; and to my mind it seems impossible to maintain that cells so large and well-defined in outline could be formed by an involution and budding of the tiny cells of the germinal disk, which, under a magnifying power of 100 diameters, are scarcely distinguishable.

The cells in the segregated hypoblast in fig. 2 are very distinct and quite sharply defined in outline, while with the same magnifying power in *Trachinus* these cells are indistinguishable. The embryonic shield at this stage is also larger in proportion to the size of the egg than that of *Trachinus*; and when the embryo begins to make its appearance, this shield occupies the greater portion of a surface view of the egg. Before the keel can be made out, the cells in the centre of the shield become smaller and smaller, until, as shown in fig. 3, they can scarcely be made out with an amplification of 50 diameters. It is quite evident at a very early stage that the young *Motella* embryo will be very long and narrow, and before the appearance of Kupffer's vesicle it occupies half the circumference of the egg. I have nothing new to report in the early development of the embryo, but it will be interesting to compare the times at which the different organs appear with those of *Trachinus*. For instance, Kupffer's vesicle, which in *Trachinus* appears before any protovertebræ are formed, and long before the closure of the blastopore, does not make its

appearance in *Motella* until at or after the closure of the blastopore, and at a time when there are at least six or eight protovertebræ. The vesicle itself is also differently constituted. In *Trachinus* it consists of a large single amber-tinted body, which is quite transparent and shows no cell-structure with a magnifying power of 100 diameters; whereas in *Motella* it consists of a solid mass of rounded cells which increases in size with the formation of the intestine, and gradually disappears again as the latter is pushed backwards towards the tail. In *Trachinus* Kupffer's vesicle disappears before the tail begins to grow free from the yolk, and also before the heart begins to pulsate; while in *Motella* the tail has grown free some distance and got a curious twist in it (fig. 6) before the vesicle disappears. In *Motella* also the tail grows as a free prolongation for some time before the heart begins to pulsate. The first formation of the heart and alimentary tract takes place in *Trachinus* at the time of the closure of the blastopore, and when Kupffer's vesicle is increasing in size. In *Motella* they do not arise until the blastopore has been closed some time, and Kupffer's vesicle has passed its maximum development. Early on the third day the embryo presents the appearance shown in fig. 5. The part of the yolk immediately under the head then contracts, and during the next twenty-four hours the boundary of the existing cavity is pushed back so as to enclose the space in which the heart is formed, as shown in fig. 6. Early on the fourth day it was noticed that the oil-globule in all eggs had an investing membrane binding it to the yolk. This probably consists of hypoblast, and was left behind with the advance of the blastodermic rim over the yolk, as suggested by Ryder. On the fifth day the membrane investing the oil-globule contains from two to five pigment-spots.

The embryos hatch out from 5½ to 6 days after fertilization under the following conditions of temperature. The temperature of the water in the tanks varied during the six days from 55°·5 F. to 51°·3, but during the daytime the temperature of the water in which the eggs were developing would usually rise to 60°, or even 62°, and then gradually sink again during the night to that of the water in the tanks. A ventral view of the newly-hatched fish is shown in fig. 7, and a side view in fig. 7 *a*; soon after hatching, however, the continuous embryonic fin expands dorsally and ventrally, as shown by the dotted lines in fig. 7 *a*. A comparison of these figures with those of the newly-hatched

embryo of *Trachinus* (Linn. Soc. Journ. Zool. vol. xviii. pl. 6. figs. 27 and 28), shows at once that the *Motella* embryo is not so advanced in development as that of *Trachinus*. This of course might be expected from the earlier period at which it hatches. The head is strangely backward in development in the newly-hatched fish, and, as we shall see, presents very curious features during its later modifications. The thickening for the ventral fins is only just visible, as will be seen in fig. 7. It is about this time that the air-bladder is budded off from the respiratory section of the alimentary tract just in front of the liver. It does not, however, become very distinct until the body becomes more thickly pigmented, when it is easily seen as a clear space surrounded by pigment. The embryo in this stage measures 2·25 millim. long by ·55 millim. deep. At the time of hatching there is little pigment on the body, but this is quickly deposited, until when two days old there is so much pigment about the jaws and mesenteron as to make further development difficult to follow. Figures 8 and 8*a* give ventral and lateral views of the embryo, about forty hours later than fig. 7. The yolk-sac has been considerably absorbed, leaving the heart in a large pericardiac cavity, the remains of the segmentation-cavity, which persists so long as any yolk is left. The ventral fins have grown considerably, and are now nearly as large as the pectoral. The principal changes, however, are in the head. The brain-lobes have increased very considerably in size, are well marked out for the first time on a lateral view, the cerebellum has now been segmented off, and the medulla oblongata is very much increased in bulk. Changes now take place in the head which are difficult to follow; and further work on this point is necessary in order to understand them properly. The dorsal portion of the head grows much more rapidly than the ventral portion up to a certain point. The result is that a cranial flexure is produced which is different from anything I have observed in other Teleosteans, and is in some respects comparable with the early embryonic condition of Elasmobranchs. In the latter, it is true that the characteristic feature of this flexure is that the mid brain is pushed forward until it forms the most prominent part of the body, and is in fact, for the time being, the termination of the body-axis. In Elasmobranchs, however, the mouth is situated ventrally in the adult, so that the embryonic mouth and brain have not again to change their relative position, as would be the case in a Teleostean with an embryonic cranial flexure. In *Motella* the mid brain can

scarcely be said to be *anterior* to the fore brain; but, as will be seen from figures 9 and 10, it occupies a position quite as prominent. The truth is, that the brain develops very rapidly, while the jaws remain comparatively undeveloped, so that the fore brain is pushed forwards and downwards until the mid brain lies completely over it. Another consequence of this rapid growth is that the mouth takes up a temporary ventral position (figs. 9 & 10). At this time the mouth is only slightly open, and the lower jaw is not so prominent as the upper one. Their relative position will easily be understood by reference to fig. 9 *a*. When, however, the brain has reached its maximum development, the ventral portion of the head begins to play its part, and the cranial axis is gradually pushed back into its normal position as the lower jaw increases in size. This time the greatest development is on the extreme ventral surface, and the lower jaw now outstrips the upper one in dimensions. The time occupied by all these changes is from 6 to 6½ days, and their course will easily be followed by a comparison of figs. 7 to 14.

About a day after hatching, a small clear vesicle arises in the immediate vicinity of the liver, which is probably the gall-bladder. This vesicle remained transparent as long as the young fish lived. In *Cyclopterus lumpus*, however, I have observed a similar gland, which gradually becomes filled with a bright green fluid, seen at a glance in the living embryo. As is usual with pelagic fish-eggs, there is no circulation either embryonic or vitelline in *Motella* before hatching, nor, indeed, for some days afterwards. From six to seven days after hatching a rudimentary circulation was observed, but it was very faint, and no vessels were properly formed. Soon afterwards the young fish died, so that I have no reliable data on this point. The arrangement of the vessels in the early circulation of Teleostean embryos seems to vary very much in different forms that have been studied; and so far as I am aware no thorough comparative study of this development has yet been made. In *Cyclopterus* I have found an arrangement differing in many important points from other forms already described, and *Motella* seems to have something in common with *Cyclopterus*. There is, first of all, an aortic circulation pushed backwards as far as the anus, and the corpuscles return in a lower area of the same tissue before the vessels themselves are formed. From this system a branch is given off near the constriction in the intestine, which soon bifurcates, sending a branch backwards to the anal gut, and a branch forwards to the

heart. It is this lower return branch to the heart which would seem to be the homologue of the large vessel in *Cyclopterus*, which distributes the blood around the yolk before it is again collected in the heart. In *Motella*, also, this vessel passes over what is left of the yolk on its way to the heart. Further work, however, is needed on this point before any true analogy can be established.

During the first few days of the embryo's free existence, the pectoral fins far outstrip the ventrals in dimensions. A reference to fig. 11 shows the pectorals as large, flat, leaf-like expansions, while the ventrals are thick and short, with an undulating margin, and are deeply pigmented.

Agassiz (" On the young stages of some Osseous Fishes," part iii., Proc. Amer. Acad. of Arts and Sciences, new series, vol. ix. 1882) expresses a doubt whether the young stages which he has figured as *Motella argentea* belong to that genus, and are not rather the young of *Onus*, in which the ventrals are developed to an extraordinary degree in the young, reminding one of the specialized development in Flying-Fishes. I am not aware whether Agassiz's figures have since been identified; but if they really represent *Motella*, it is easy to see how the ventral fin, as represented in my fig. 11, could be developed so as to agree with Agassiz's pl. vii. fig. 1.

There appears to be one point in which the Gadidæ differ in their development from all other Teleosteans of which the development is known, and that is the late period at which the anus opens externally on the ventral surface. The exact time at which this takes place is not known. Ryder figures the young of the Cod 7 days after hatching (" Contrib. to the Embryog. of Osseous Fishes: " Report of the Commissioner of Fish and Fisheries for 1882. Washington, 1884, pl. xii.), with the intestine and anal gut having no opening externally; and in the oldest embryos I have had of *Motella* (*i. e.* 6½–7 days after hatching) I have found the same to be the case. It would appear, then, as if the young Gadidæ were not in a position to take solid food at nearly so early a period in their development as is usually the case with Teleostean embryos.

There is another point which is worthy of notice in the development of pelagic ova, namely the length of time which the embryo spends *within* the egg. The following is a list of the principal species of pelagic eggs observed, where the observers state the time of hatching:—

Julis vulgaris (Hoffmann): 52 hours.

Scorpæna porcus (Hoffmann): 58 hours.

Scorpæna scrofula (Hoffmann): 58 hours.

Fierasfer acus (Hoffmann): probably 58–60 hours.

Spanish Mackerel (Ryder): 24 hours, some even 20 hours; and, if temperature unusually low, 36 hours.

Codfish (Ryder): 20 days (38° F.); has been known to hatch in 13 days (45° F.).

Codfish (Sars): 16 days; 18 days at very low temperature.

Cunner (*Ctenolabrus cæruleus*) (Kingsley and Conn): 2 days.

Fierasfer acus (Emery): 3rd day.

Cunner and others (Agassiz and Whitman): 50 hours.

Pseudorhombus oblongus (Agassiz and Whitman): 40 hours.

Trachinus vipera (Brook): 10th day, 58° F.

Motella mustela (Brook): 6th day, 55°–60° F.

It will be noticed that the embryos in the above list hatch out at a time varying from 20 hours to 20 days. The question is, how far this disparity is a natural feature of the egg, and how far it depends on temperature. I have already called attention to the varying period at which the embryos of *Trachinus* hatch out according to the temperature; and there is no doubt that within certain bounds a higher or lower temperature will proportionately accelerate or retard the development of this species. Unfortunately we have no details of the temperature at which most of the observations were made. The species mentioned by Hoffmann * were studied at Naples in the spring and summer, when the temperature of the surface of the sea would be very high, and thus far the short time taken to hatch out may *in part* be accounted for. Ryder's observations † on the Spanish Mackerel would also be carried on at a high temperature, but even taking that into consideration, the development is remarkably rapid. The same may be said of the observations of Kingsley and Conn ‡, and Agassiz and Whitman §. The Codfish spawns in the winter time; and we notice at once the much greater time spent by the embryo within the egg, and also that to some extent the date of hatching depends on the temperature. In some of the non-pelagic eggs laid in the winter, such as the Trout and Salmon, a

* Natuurk. Verh. d. koninkl. Ak. Amsterdam, xxi. (1881).

† Bull. U. S. Fish. Comm. i. (1881).

‡ Mem. Bost. Soc. Nat. Hist. iii. (1883).

§ Proc. Amer. Acad. of Arts and Sciences, xx. (1884).

sudden rise of temperature will often kill the eggs; and it is a fact well known to pisciculturists that a greater percentage of the ova of these forms is hatched out successfully when the temperature is kept low.

How far, then, a summer-breeding fish requires a high temperature and a winter-breeding fish a low one depends doubtless on features which have been adopted owing to the influence of the environment. There is still, however, a certain range of temperature to which each developing embryo can accommodate itself according to its kind; and I cannot help thinking that until we know more of the influence of this varying range, we shall not be able to compare satisfactorily the development of one fish with another.

DESCRIPTION OF THE PLATES.

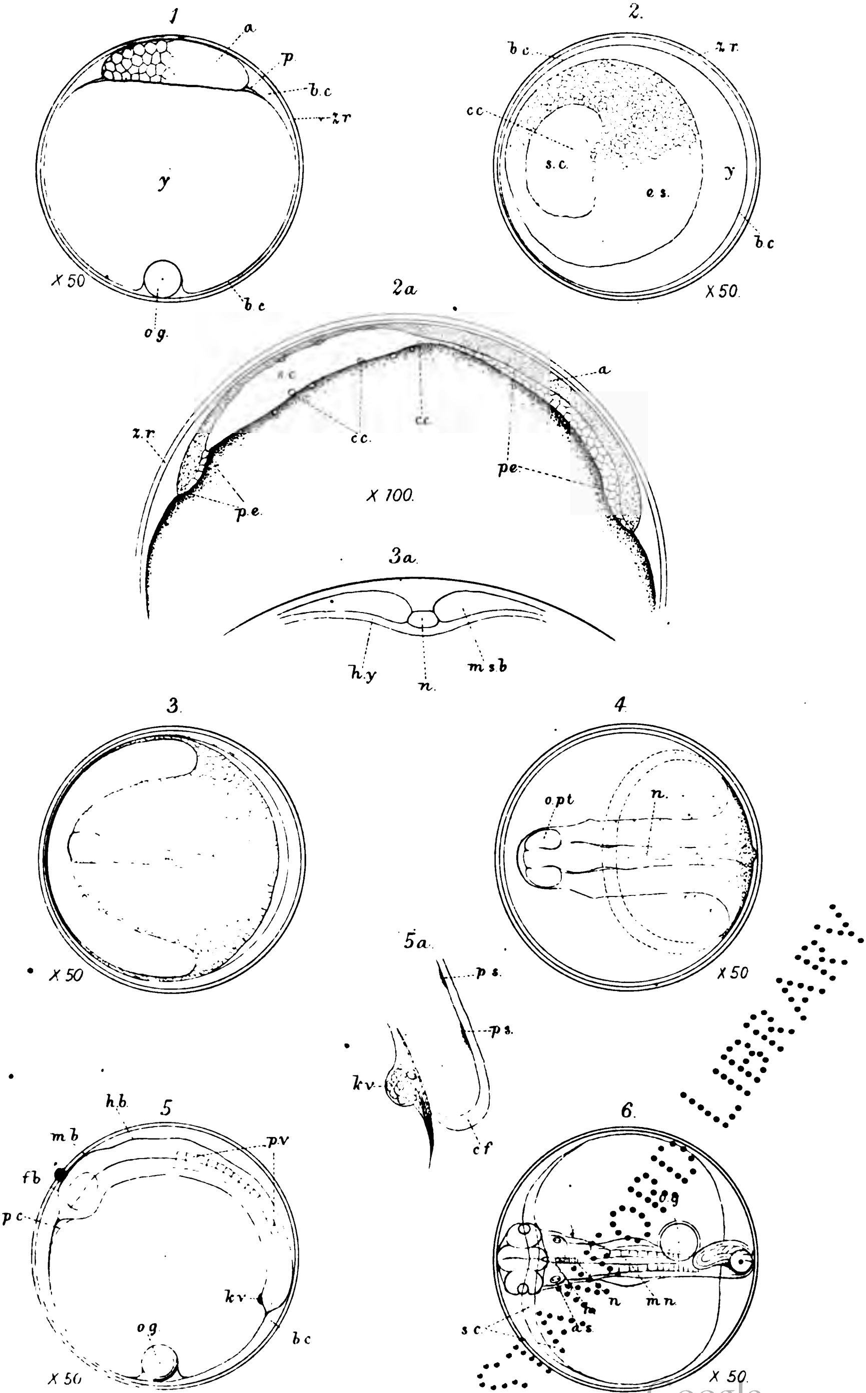
Lettering used throughout the Plates.

a. = archiblast.
a. s. = auditory sacs.
b. = clear glandular body (probably the gall-bladder), referred to in text, p. 303.
b. c. = breathing-chamber.
br. = branchial arches.
c. = cerebellum.
cc. = loose cells and nuclei lying on the floor of the segmentation-cavity.
c. f. = caudal portion of the continuous embryonal fin.
e. s. = embryonal shield.
f. b. = fore brain.
h. = heart.
hy. = hypoblast (true) or secondary entoderm.
h. b. = hind brain.
K. v. = Kupffer's vesicle.
l. = liver.
l. j. = lower jaw.
m. = mouth.
msb. = mesoblast or mesoderm.
m. b. = mid brain.
mn. = mesenteron.
m. o. = medulla oblongata.
n. = notocord.
n. p. = nasal pit.
o. g. = oil-globule.
opt. = optic lobes.
p. = periblast (parablast) or nuclear zone.
p. s. = pericardial sinus.
p. e. = primary entoderm or hypoblast.
p. f. = pectoral fin.
p. s. = pigment-spots.
p. v. = protovertebræ.
py. = pyloric constriction of the intestine.
s. b. = swim-bladder.
s. c. = segmentation-cavity (both before and after its extension around the yolk).
u. v. = urinary vesicle.
u. j. = upper jaw.
v. f. = ventral fin.
y. = yolk.
z. r. = zona radiata.

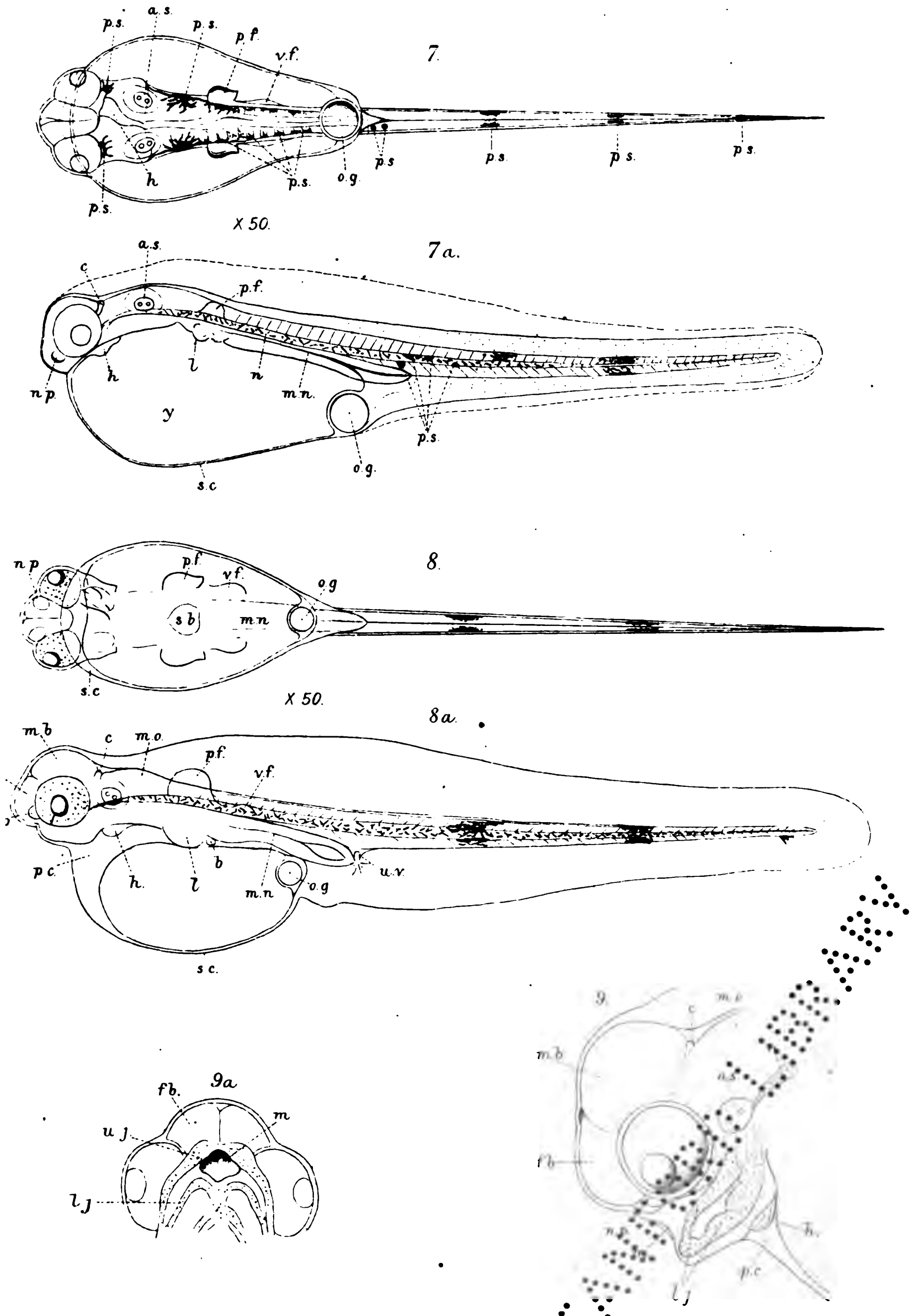
The forming cartilages of the jaws are shown as dotted tissue in figs. 9, 9 *a*, 10, & 11.

The details of the alimentary tract are more hidden by pigment than is shown in figs. 10 & 11.

The direction of the circulation is indicated by arrow-heads in fig. 13.



E. Carter sc. DEVELOPMENT OF MOTELLA MUSTELA. Mintern Bros imp.


7.
p.s.
a.s.
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h
p.s.
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X 50.
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u.v.
s.c.
9a
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a.s.
h.
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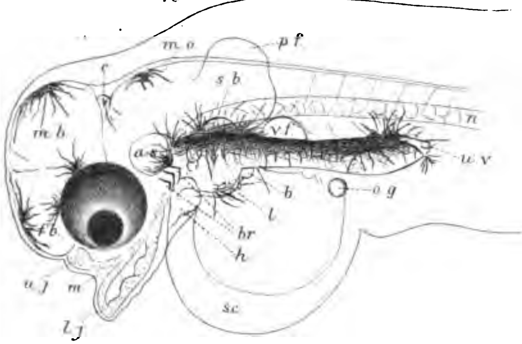
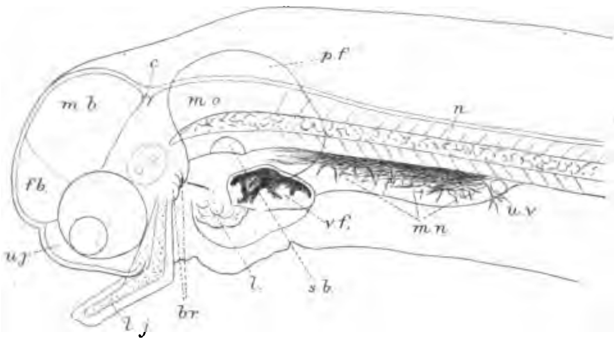
l.j

10



10 a

11.



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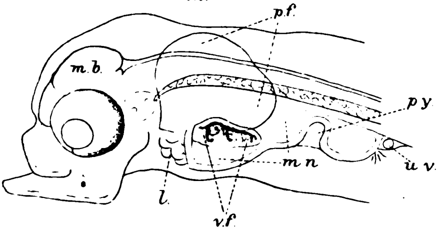

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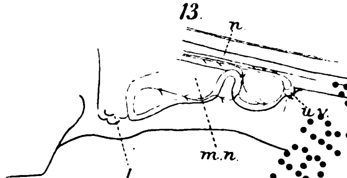

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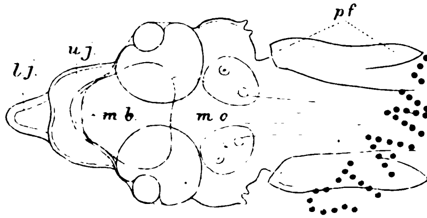


Plate VIII.

Fig. 1. Optical section of the whole egg on the first day, showing segmentation-mass, with the epidermic layer of the epiblast already differentiated, and the periblast around the rim of the disk.

2. Surface view of egg (as floating) just over one day old, showing cell-formation in the embryonal shield.

2 *a*. Optical section of same stage, showing formation of the hypoblast and free cells in the yolk and on the floor of the segmentation-cavity.

3. View of the embryonal shield 6 hours later than fig. 2, showing first formation of the embryo.

3 *a*. Optical section of fig. 3, showing the notochord.

4. Surface view of the embryo 5 hours later than fig. 3.

5. Surface view of embryo about 12 hours later than fig. 4 (early on third day).

5 *a*. Caudal end of embryo in fig. 5, enlarged to show the caudal plate (Ryder), and the structure of Kupffer's vesicle.

6. View of embryo as floating early on 4th day, and 24 hours later than fig. 5.

Plate IX.

Fig. 7. Ventral view of newly hatched embryo.

7 *a*. Side view of same embryo. Dotted line shows the extension of the embryonal fin some hours after hatching.

8. Ventral view of young fish 1½ day old.

8 *a*. Side view of same stage.

9. Head of young fish 2 days after hatching, showing the cranial flexure and the ventral position of the mouth.

9 *a*. Ventral view of the head in same stage, showing the mouth and the arrangement of the bony plates.

Plate X.

Fig. 10. Anterior portion of a young fish 2½ days old, showing arrangement of pigment and the further development of the cranial flexure.

10 *a*. Dorsal view of same stage.

11. Anterior end of a young fish 4½ days old, showing further development of the jaws.

12. Anterior end of a young fish 5½ days old, showing the change in the relative position of the brain brought about by the rapid development of the jaws.

13. Portion of young fish 6½ days old, showing rudiments of circulation.

14. Dorsal view of anterior portion of young fish in same stage.

Relationship of the Indian and African Freshwater Fish-Faunas. By Francis Day, F.L.S.

[Read 4th December, 1884.]

Among the many interesting problems in Zoology, few exceed that of the Geographical Distribution of Animals, in which the freshwater fish-fauna holds no inconspicuous place. It is therefore highly advisable that when discussing such a question, facts should be first ascertained, and theories be founded on them, for if the former are not quite accurate, the latter may be untenable.

During the years 1877, 1878, and 1879, I had the honour of reading three papers before this Society on "The Geographical Distribution of the Freshwater Fishes of India," deduced from personal researches into the fish-fauna of that empire. I compared that fauna with the African and that of the Malay Archipelago, and these papers were published in the Journal of this Society *. All the species alluded to with their local distribution will also be found in my 'Fishes of India,' which was published in four parts at the following dates:—Part I. August 1875, Part II. August 1876, Part III. August 1877, and Part IV. August 1878.

In 1880, about October, Dr. Günther brought out his 'Introduction to the Study of Fishes,' wherein he adduces a different statement of facts, to a great extent due to his examining groups instead of genera and species, and consequently arrives at widely different conclusions from mine; but it would seem to me possible that, owing to some oversight, he has omitted whole genera from his list of Indian freshwater forms, and likewise misplaced marine ones to among such as belong to the freshwater. That he had not even referred to my 'Fishes of India' is evident, for he remarks (*l. c.* 1880, p. 30) that it "contains an account of the freshwater and marine species, and is not yet complete," whereas the entire work had been published by August 1878†.

I think, from a close examination of his figures, that I am correct in asserting that his tables are compiled from the species enumerated in the 'Catalogue of Fishes in the British Museum,' to which are added those subsequently admitted into the 'Zoo-

* Part I. *Acanthopterygii*, vol. xiii. p. 138, Feb. 28th, 1877; Part II. *Siluridæ*, *l. c.* p. 338, Aug. 20th, 1877; and Conclusion, vol. xiv. p. 543, April 23rd, 1879.

† See also 'Encyclop. Brit.,' art. Fish, xii. p. 635, wherein Dr. Günther has reiterated his statement, but in a different way.

logical Record,' unless in some instances of a few species, which, having obtained access into the latter publication, have not been counted in the enumeration in the 'Introduction to the Study of Fishes,' or else it may be that some of the species in the 'Catalogue' have been suppressed owing to further research *.

Up to the present my time has been so occupied that I have been unable to analyze the two statements, a very necessary work if it is desired to know whether any, and if so where, the difference lies. To the remarks I made in the Society's Journal I have nothing to add, so in this paper shall simply refer to them. "*India*" in my paper only including "India, Burma, and Ceylon," whereas the "*Indian region*" of Dr. Günther includes "Asia south of the Himalayas and the Yang-tse-kiang, and the islands to the west of Wallace's Line." As I found in India proper 19 genera of Acanthopterygian fishes, whereas Dr. Günther only admits 16 genera in his larger "Indian region," of which mine forms merely a little more than half, there must exist some great error on one side or the other.

I will first consider *what is a freshwater fish*? A reply to such a question would appear to be easy. If a fish lives entirely in fresh water, rears its young there, and never descends to the sea, such surely would constitute a strictly freshwater form, as several species of *Ambassis*, Gobies as *Gobius giuris*, Mullets as *Mugil cascasia*—forms entirely omitted from Dr. Günther's list, although, if his Catalogue is referred to, it will be found that he defines the genus *Ambassis* as "small fishes living in the fresh and brackish waters, and in the seas of the Indian region" (i. p. 222), and he restricts some entirely to fresh waters. As regards the genus *Gobius*, their habitat in the Catalogue (vol. iii. p. 5) is given as "found on all the coasts of the temperate and tropical regions, many species entering fresh waters, and some entirely confined to them;" and although *Gobius giuris* (*l. c.* p. 22) is

* Dr. Günther (Introd. Study of Fishes, p. 226) observes, with reference to relations of the Indian region in freshwater fishes to that of the Tropical Pacific, that the following must have immigrated from the former into the latter—"*Lates calcarifer*, species of *Dules*, *Plotosus anguillaris*," and "species of *Arius*." He continues, "All these fishes must have migrated by the sea; a supposition which is supported by what we know of their habits." If he had continued that all these forms are marine and not belonging to a freshwater fauna, he would have been correct in the observation, and made the reader, who has not been in the east, more readily understand why it was they should have come by the sea.

stated to be "found on all the Indian coasts, entering fresh waters," it is very doubtful whether more than one species are not included under this head. I found this fish throughout the freshwater regions I examined, from the Punjab to Cape Comorin, from Sind to the eastern extremity of Burma, and even some way up the Himalayas, living and breeding in fresh water, where their young were being reared.

Then we have catadromous forms which I should locate among those of the freshwater, but of these there are, so far as I am aware, only the Eel. There are a considerable number of anadromous forms, and these are not so easy to arrange as to whether they are or are not to be considered freshwater or marine fishes. Among anadromous forms we find some, as in the Salmon of our rivers, which ascend to breed, and wherein the young continue until they may be in a condition to propagate their kind : these would rank among freshwater forms. Then we have the Shad, which likewise ascends rivers to breed, but the young do not appear to be raised in the rivers, unless in the lower reaches, and these could hardly be termed freshwater fishes. Similarly among the species in India, it may be questionable whether the *Sciæna coitor* may not be a simple anadromous form wherein the young drops down to the sea; but this I do not think to be the case, as I have found the young in rivers far above impassable weirs. In the following paper I have thought it advisable to omit, as far as possible, my own observations made among the fishes in India, as such have already been published, and to give the opinions of others who have worked in the same localities as field-naturalists, and whose records are the results of what they have personally found. Following this course, I think it possible to show that I was and am entirely justified in placing the fishes I did among the Indian freshwater fish-fauna, although they have, subsequent to the publication of my papers, been rejected as such by Dr. Günther, and that without any comment or explanation being given for the course which he has adopted.

Dr. Günther furnishes an elaborate list of the forms of freshwater fish inhabiting the Indian region (Introduction to the Study of Fishes, p. 220), and of the Acanthopterygians as follows :—

"Percina, *Lates* (also Africa)."—This first genus in India is not a freshwater form, but found in the mouths of rivers, up which it

occasionally ascends in pursuit of prey*. In the 'Catalogue of Fishes of the British Museum,' it is observed that it is found at the "mouths of large Indian rivers" (vol. i. p. 67), and even in the 'Introduction' (p. 377), that it is the "Perch of the Ganges and other East-Indian rivers, which enters freely brackish waters." Hamilton Buchanan (Fishes of the Ganges, p. 87) remarks that "the *Vacti* abounds in all the mouths of the Ganges, which it ascends as far as the tides, and follows this into marshes, ditches, and ponds; but those found in salt water are of by far the best quality." Bleeker, in his 'Fishes of Bengal,' gives as its habitat "Ostia Gangetica, Coromandelia." Cantor, in his 'Malayan Fishes' (p. 2), observes that it is found in the "Bay of Bengal, estuaries of the Ganges, Indian Ocean," &c. This genus must be erased from among those composing a portion of the freshwater fish-fauna of India.

Genus *Ambassis*.—Dr. Günther does not include this genus (which is absent from Africa) as among the Indian freshwater forms. In his 'Catalogue' (p. 222), he gives as its geographical distribution, "small fishes living in the fresh and brackish waters and in the seas of the Indian region," &c.; and in his 'Introduction' (p. 394) that "they are most abundant on the coasts of the Tropical Indo-Pacific and in the freshwaters belonging to that area." Hamilton Buchanan observes of *Chanda*† *nalua* (p. 108), that it is "found in the freshwater rivers of Lower Bengal;" of *C. nama*, that it "is common in ponds throughout Bengal" (p. 109); of *C. phula*, that it "is found in the ponds and rivers of the north-eastern parts of Bengal" (p. 111); of *C. bagoda*, that it "is also found in the north-eastern parts of Bengal" (p. 111); *C. baculis* in the same locality (p. 112); *C. ranga* "is found in the fresh waters of all the Gangetic provinces" (p. 113); and *C. lata* "is found along with the last described" (p. 114). Bleeker, for different Indian species, gives Dekkan Bengalis, Loodinah, and Jihlum Glum. Sykes, in his "Fishes of the Dukhun" (Trans. Zool. Soc. ii. 1841), gives *Ambassis Barlovi* as a species "found in the Beema river at Pairgaon" (p. 350). From the foregoing one would imagine that (leaving my observations out of the question) the evidence of every author who

* It is unnecessary to observe upon how many sea-fishes, as the European Bass &c., may be acclimatized to freshwater when they are unable to obtain access to the ocean

† This genus is identical with *Ambassis*, C. & V.

has made the study of Indian fishes his occupation might be entitled to some credence, and that many of these forms are distinctly freshwater species.

Consequently, among the PERCINA, instead of the *Lates*, common to India and Africa, being the only genus in the fresh waters of the Indian region, it must be erased from such a list, and restricted to a marine fauna; while *Ambassis* has to be introduced among the freshwater fauna, a genus which is absent from Africa.

Next in succession Dr. Günther gives the following:—NANDINA, 7 species, consisting of *Badis* 2 species, *Nandus* 2 species, *Pristolepis* (he elects to term it *Catopra*) 3 species, as recorded in the British-Museum Catalogue. These numbers would seem to omit the *Pristolepis marginatus*, Jerdon, and *P. malabaricus*, Günther, both restricted to the Indian region.

"LABYRINTHICI (Africa), 25 species."—If we add the species admitted into the 'Zoological Record' to those in the British-Museum Catalogue, we obtain as follows:—*Anabas* 4, *Holostoma* 1, *Polyacanthus* 7, *Macropus* 1, *Osphromenus* 6, *Trichogaster* 4, *Betta* 2, or 25 species. Now, although the genera *Spirobranchus* and *Ctenopoma*, both belonging to the Labyrinthici, are found in Africa, they do not extend to the Indian region. The genera of this family present in Africa are distinct from the genera which exist in Asia; or Labyrinthici includes 7 Indian and 2 African genera, none of which are common to both regions.

LUCIOCEPHALIDÆ.—Represented by a small species of *Luciocephalus* found in the East-Indian archipelago.

SCIÆNIDÆ.—Members of this family, in the 'Introduction,' find no place among the freshwater fish-fauna of India. Genus *Sciæna* affords one species, *S. coitor*, that lives and breeds in many of the Indian rivers. Hamilton Buchanan observes:—"This fish is found in the Ganges, from the sea up as far at least as Kanpur (Cawnpore), and in the Jumna as far as Agra. It is, however, much more common where the tide reaches, although its quality improves in the upper parts of the river, especially where the shores are rocky" (Gangetic Fishes, p. 75). In the 'Introduction to the Study of Fishes,' Dr. Günther observes of *Sciæna** *coitor* on its being one of the most common fishes on

* He makes the same remark of *S. diacanthus*, a species which only ascends as far as the tidal influence reaches, or perhaps a little above; while *S. coitor* breeds in rivers above large weirs destitute of any fish-passes.

the coast of the East Indies, ascending the great rivers for a long distance from the sea (p. 430).

GOBIIDÆ.—Members of this family are omitted by Dr. Günther from among the freshwater fish-fauna of India. In the district or division to which I restricted my designation of "India," several genera are found having representatives in the fresh waters, and which I will enumerate.—*Gobius*: Dr. Günther says, "Not a few have become entirely acclimatized in fresh waters, especially lakes" (p. 486).—*Gobius giuris*, H. B. Hamilton Buchanan observes that it is found "in all the ponds and freshwater rivers in the Gangetic provinces, where it is a very common fish" (Gangetic Fishes, p. 51); Bleeker, that it is found in "Bombay, Bengalia, Jihlum, Dukhun" (p. 51); Sykes gives it as in the Deccan under the designation of *Gobius kurpah* (*l. c.* p. 352); Jerdon says *G. kokius* is "very common in tanks, rivers, and ditches throughout the south of India" (Madras Journ. Lit. & Science, 1849, vol. xv. p. 148).

Genus *Sicydium*, of which I have obtained two species, one from fresh waters in Burma, the other from fresh waters in Canara. In Dr. Günther's 'Introduction' he says of these fish, "Small freshwater fishes inhabiting the rivers and rivulets of the islands of the Tropical Indo-Pacific" (p. 487). Possibly my species, which are figured in the 'Fishes of India,' have been overlooked; also Bleeker's, referred to in the 'Catalogue of the Fishes of the British Museum' (vol. iii. p. 93), as *S. xanthurum* from "rivers of West Sumatra and Bali," *S. micrurum* from "rivers of Amboyna and Bali" (p. 94), &c. &c.

Genus *Periophthalmus*, of which I obtained *P. Schlosseri* in fresh waters, especially in the Irrawaddi and its branches, as well as in estuaries.

Genus *Eleotris*.—I have found the *E. fusca* in fresh waters; while of this genus Dr. Günther (Introduction, p. 488) observes on "some of them being abundant in the rivulets of the islands of the Indo-Pacific." Hamilton Buchanan, alluding to this species under the designation of *Cheilodipterus culius*, says it "is pretty common in the ponds and ditches of Bengal" (*l. c.* p. 55); Jerdon, that "it is very common in Malabar in ditches and tanks" (*l. c.* p. 149).

Thus it appears that in the list of the Indian freshwater fish-fauna the family of GOBIIDÆ has been omitted by Dr. Günther

although it has representatives residing inland of species of the genera *Gobius*, *Sicydium*, *Periophthalmus*, and *Eleotris*.

"MASTACEMBELIDÆ (or RHYNCHOBDELLIDÆ), 3 species in Africa; 10 species" in the Indian region.—In the 'Catalogue' vol. iii., *Rhynchobdella* 1 species, and *Mastacembelus* 8 species, are given. In the 'Zoological Record' are added in this region *Rhynchobdella sinensis*, Bleeker, *Mastacembelus fasciatus*, Bleeker, and *M. Guentheri*, Day.

CHROMIDES.—Two species of *Etroplus* are admitted from India, *E. canarensis*, Day, being probably rejected: a figure of this form from the life along with *E. maculatus* are therefore exhibited, all three forms being fully described and figured in the 'Fishes of India' and alluded to in the 'Zoological Record.'

MUGILIDÆ, omitted from the list of freshwater fishes in the Indian region. One of the three forms, *M. Hamiltonii*, I discovered in the fresh waters of Burma. Of *M. corsula*, Hamilton Buchanan observes that it "is found in most rivers of the Gangetic provinces, and in the southern parts of Bengal has been introduced into some ponds" (Gangetic Fishes, p. 221); of *M. cascasia* he remarks, "This fish I found in the northern rivers of Bengal" (*l. c.* p. 217). According to my views these Mullets, which live and breed in fresh waters, belong to the freshwater fauna.

"OPHIOCEPHALIDÆ 30 species (1 from Africa)."—In the Catalogue, 25 species of *Ophiocephalus* and 1 of *Chauna* are stated to exist in the Indian region as defined in the 'Introduction.' In the 'Zoological Record' are 4 more species of *Ophiocephalus*, with localities given, which would complete the list. Although only one species, (I suppose) *O. obscurus*, Günther, is given from Africa, possibly *O. africanus*, Steind., from West Africa, was unintentionally omitted.

In questions of geographical distribution more information is desirable than such as the following: "Ophiocephalidæ are found in India, China, and Africa;" for this might raise the supposition that they were equally common in all these localities: such, however, is by no means the case, they may abound in one or two of those districts, but be very sparsely distributed in a third. The abundance of forms ought to be considered along with their presence. Again, if one genus of a family has representatives in Africa, and 10 or 15 in Asia, it may be true that such a family is common to both continents, but such is the case to only a limited

extent. Consequently, one can scarcely argue that, because two genera of Labyrinthici are sparingly found in Africa and seven in Asia, some of these last being composed of many species or varieties extending in large numbers over wide distances, that the fishes of this family are common to the two continents, which, although true in fact, may be misleading without any explanation.

Respecting the SILURIDÆ, the marine and freshwater forms have been so mixed up in the 'Introduction to the Study of Fishes' (p. 222), that there will be a little difficulty in disentangling them; but to do this I must examine them in succession.

"CLARIINA (Africa), 12 species" (Introduction, p. 222).—11 forms pertaining to his Indian region are given in the Catalogue (vol. v.); also of CHACINA 3, as in 'Introduction'; of SILURINA 63 species (several nominal) are given in the Catalogue for this region, and more are in the 'Record.'

"BAGRINA (Africa), 50 species."—*Macrones*, 20 species; *Pseudobagrus*, 4 species; *Liocassis*, 4 species; *Bagroides*, 3 species; *Bagrichthys*, 1 species; *Rita*, 4 species; *Acrochordonichthys*, 6 species; *Akysis*, 3 species; *Olyra*, 1 species; *Branchiosteus*, 1 species; or 47 in the Catalogue. The omitted species it is unnecessary to follow out.

"ARIINA (Africa, Australia, and South America), 40 species." —Here again we have a large marine and estuary family placed among the freshwater fish-fauna! It is captured within the influence of the tides, or even occasionally ascending into and becoming imprisoned in brackish waters, and so may be left there until the next year's rains; but it is hardly correct to say "Some of the species prefer brackish to fresh water, and a few enter the sea but keep near to the coast" (p. 569). Hamilton Buchanan says of *Ageneiosus mino*, "This fish is found in the upper part of the estuaries, that is, where the water possesses little or no saltness" (Gangetic Fishes, p. 159); *Pimelodus gagora*, "It is common in the estuaries of Bengal" (*l. c.* p. 167); *P. sagor* "is found along with *gagora*" (*l. c.* p. 169); of *P. arius*, "found in the same places as the *gangora*" (*l. c.* p. 170); *P. jatius* "is found in the same place, grows to the same size, and has similar colours to the *gagora*" (*l. c.* p. 171); *P. nenga*, "found in the same place" (*l. c.* p. 172); *P. soua*, "found in the same places" (*l. c.* p. 172). Cantor, in his 'Malayan Fishes,' only found

species of *Arius* in the seas and estuaries. Jerdon admitted none among his list of "the Freshwater Fishes of Southern India" (Madras Journ. Lit. & Sci. xv. 1849, pp. 139, 302). As far as my personal investigations in the East have gone, if the Ariinæ elsewhere have the same habit as along the coast of India, these 40 species should be erased from the freshwater fish-fauna.

"BAGARIINA, 20 species;" 16 are in the Catalogue.

"RHINOGLANINA (Africa), 1 species," as in Catalogue.

HYPOSTOMATINA (South America), 5 species."—Five in the Catalogue; but, as I long since pointed out, genus *Erethistes*, V., p. 263, is identical with *Hara*, p. 189; but this form possibly is not one of the five.

"CYPRINODONTIDÆ.—*Haplochilus*, 4 species."

SCOMBRESOCIDÆ.—Omitted from the Indian freshwater fish-fauna by Dr. Günther. *Belone cancila*: the habitat given in the 'Catalogue of the Fishes of the British Museum' (vi. p. 253) is "Indian Ocean;" I gave it as "fresh waters of Sind, India, and Ceylon, and throughout Burma." Hamilton Buchanan observes that it "is a very common fish in the ponds and smaller rivers of the Gangetic provinces" (Gangetic Fishes, p. 214). Sykes, 'Fishes of the Dukhun,' p. 367, terms it "a freshwater fish" found in the Mota Mola river at Poona. Jerdon, 'Freshwater Fishes of Southern India' (p. 345) states that "this fish is found in most of the rivers of the west coast up to the base of the mountains."

CYPRINIDÆ.—Of these as given in the list in the 'Introduction' (if we omit the majority of such as I have discovered in India) we have a fair compilation. OSTEOGLOSSIDÆ, NOTOPTERIDÆ, and SYMBRANCHIDÆ call for no observations.

If we analyze Dr. Günther's list with the foregoing remarks, we obtain the following results:—

Present in Indian and African regions:—1 Labyrinthici, 2 Ophiocephalidæ, 3 Mastacembelidæ, 4 Chromides, 5 Clariina, 6 Silurina, 7 Bagrina, 8 Rhinoglanina, 9 Cyprinodontidæ, 10 Cyprinina, 11 Rasborina, 12 Danionina, 13 Abramidina, 14 Osteoglossidæ, 15 Notopteridæ. The groups Percina, genus *Lates*, and Ariina must be erased, as not belonging to freshwater fauna.

Restricted to India:—1 Nandina, 2 Luciocephalidæ, 3 Chacina, 4 Bagariina, 5 Hypostomatina, 6 Semiplotina, 7 Homalopterina, 8 Cobitidina, and 9 Symbranchidæ.

But the following additions have to be made. Among the SCIÆNIDÆ, genus *Sciæna*, which has representatives among the freshwater fish-fauna of India, as have also the GOBIIDÆ, but whether any of the former are found in African fresh waters is hardly proved, but some of the latter have been.

Among the PERCINA, genus *Ambassis* is present in Indian fresh waters, but is not found in Africa.

Although Dr. Günther limits the investigations made into the fish-fauna of the Alpine tracts of the Himalayan region to what Griffith accomplished, the researches of Dr. Stoliczka showed that he obtained freshwater forms in Tibet at nearly 16,000 feet above the sea-level *.

But it may well be asked, Is it by examining large groups of fishes as a whole, or by investigating their distribution in genera or species, that we obtain the most accurate information as to the zoological affinities between different localities? I consider the latter plan is that which is best suited for this purpose, and in examining the analogy between the Indian and African freshwater fish-faunas, I find as follows:—

In India, as restricted, I found 87 genera of freshwater fishes, of which only 14 have representatives in Africa; while among the 369 species of which these genera are composed, only 4 extend to Africa. If we examine the relationship of the same fauna in this restricted Indian area we find, of the 87 genera, 44 extend to the Malay Archipelago, and of the 369 species, 29 are present in both localities; or, tabulated, it comes as follows:—

Indian Freshwater Fishes.

87 genera:—14 extend to Africa; 44 to the Malay Archipelago.
369 species:— 4 extend to Africa; 29 to the Malay Archipelago.

* Dr. Günther, 'Introduction to the Study of Fishes,' p. 227, observes:— "No observations have been made by which the altitudinal limits of fish-life in the Himalayas can be fixed; but it is probable that it reaches the line of perpetual snow, as in the European Alps, which are inhabited by Salmonoids, Griffith found an *Oreinus* and a Loach, the former in abundance in the Helmund at Gridun Dewar, altitude 10,500 feet, and another Loach at Kaloo at 11,000 feet." Even in the 'Catalogue of the Fishes of the British Museum,' vol. vii. p. 360, it is stated of Stoliczka's Loach, *Nemacheilus Stoliczkæ*, "Province of Rupshu (Tibet), 15,500 feet above the level of the sea."

Notes on the Habits of some Australian Hymenoptera Aculeata. By HENRY LING ROTH. (Communicated by Sir J. LUBBOCK, Bart., Pres. Linn. Soc.)

[Read 20th November, 1884.]

[MR. ROTH has recently transmitted to the British Museum, through Sir John Lubbock, a series of Ants and other Hymenoptera from Mackay, Queensland. By Mr. Roth's desire, I have selected such of his accompanying observations as appear to be of sufficient interest for publication, and have added the correct names of the species. I have also described a species of *Rhynchium* which seems to be new.—W. F. KIRBY.]

FOSSORES.

SPHEGIDÆ.

PELOPÆUS LÆTUS, *Smith*.

These Wasps are exceedingly common. When living in the country, it is very difficult to keep them out of the house. They build their nests anywhere and everywhere—on the walls, ceilings, on the legs of chairs, under the table, in crevices, cupboards, in vases, between pictures and the walls, in the roof, once in a pipe (12th Nov. 1883), and even on curtains.

They construct their nests very differently from *Eumenes Latreillii* (*vide infrà*, p. 321). Having chosen a desirable spot, they go in search of the necessary mud. This they obtain from the moist or wet soil on the margin of creeks or puddles. Having scraped enough particles together and made them up into a ball about the size of their thorax, they carry it away and begin building. The marks of the layers of mud are very distinctly visible. When the site chosen is not a very good one, as for instance between a picture and the wall, these cells are sometimes flattened out in course of construction as shown in the accompanying figs. 1 *a*–1 *e*. I may here remark that the layers of mud are not very distinctly shown in this figure, in consequence of the wasp having been unable to obtain sufficiently dry mud, owing to the prevailing wet weather, and the layers therefore run into one another. When the mud is very wet the wasp drops a quantity, and the ground below which she is building is frequently covered with the fallen particles.

In her flight she stridulates very like a bee, but with a much deeper tone. As soon, however, as she has settled to work either in collecting mud or in the actual construction of her nest, she

produces quite a different sound. It has now an exceedingly high pitch; and from my observations of the wasp at work, I believe it is the result of the vertical motion of the abdomen from the pedicle.

Fig. 1.

a. b. c. d. e.

a–e. Outlines, nests of *Pelopæus lætus*, nat. size.

The work which the wasp undertakes in building her nest may be judged from the number of times she takes to go to and from the wet earth. On Oct. 13, 1883, I timed a wasp at her work. In the course of 22 minutes she fetched mud at a distance of 5 yards; 13 times at the following intervals—at $14\frac{1}{2}$, $12\frac{1}{2}$, $10\frac{3}{4}$, $9\frac{1}{4}$, $7\frac{1}{2}$, $6\frac{3}{4}$, 4, $1\frac{3}{4}$ minutes to 3 o'clock in the afternoon; then at 3 P.M., 1, $3\frac{1}{2}$, $5\frac{1}{2}$, $7\frac{1}{4}$ minutes past 3, when I ceased my observations.

When one cell is completed the wasp goes in search of spiders, of which she generally collects from 15 to 22 specimens of three moderate-sized species. It is very seldom that any other species of spiders are collected. She takes them one by one and packs them half dead in the cell, being very particular as to the way in which they fit in. When the cell is full she deposits an egg, somewhat smaller than that of *Eumenes Latreillii*, and the egg is laid on one of the benumbed spiders. She then closes the top of the cell with mud and commences a fresh cell at its side. She builds the cells in a row side by side, but the row is seldom straight, and she lacks that exactitude and neatness which characterizes the work of *Eumenes*. Sometimes, if disturbed, she will close a cell without putting in any spiders at all, and at other times she will only half fill the cell. The cell-wall attains a thickness of $\frac{3}{8}$ inch. The wasp constructs from 10 to 20 of these cells in two rows one above the other, fills the interstices between the cells with mud, and smears the whole over with mud likewise, until it resembles a long lump of clay, and at this stage the nest is undistinguishable in outward appearance from that of the *Eumenes*. But if allowed to continue her work

undisturbed, she goes a step further, and by means of diagonal streaks of mud gives the nest the look of a small piece of the bark of the common European Acacia. When laying on the mud, either at the very commencement or at the end, she works it by placing it on the required spot and then drawing it backwards towards herself, after which she runs to and fro over it, thus giving it the right shape.

When the spiders are all consumed the larva pours out of its mouth a dark yellow transparent material, which forms a shell around it, and looks much like gold-beaters'-skin; at the bottom of this shell is a hard black lump, and outside the shell are found the juiceless bodies of the spiders. There is no lining to the cell. Between this shell and the cell-wall a little fluff is formed, and this keeps the former in its position.

When the perfect insect is developed (it is not doubled up in its cell) it breaks through, and after cleaning itself flies away without any preliminary canter. I have not noticed whether on emerging the little drop of liquid is produced.

These wasps are terribly infested by Dipterous and other parasites, some of which appear to destroy the larvæ indirectly by consuming the prepared food (the spiders). With the flies the case is somewhat peculiar, as the mother insect appears to follow the wasp when she is carrying a spider, and deposits her egg on the food originally intended for the offspring of the wasp. I once found two and once five (Nov. 14, 1883) cocoons of these flies. In course of development the larvæ of these flies may be seen thriving on the spiders in the same way as the larvæ of the wasp; but as they devour the juice of the spiders very quickly no food is left for the wasp's larvæ, which, being unprepared at that stage to develop into pupæ, naturally die, and the mildewed remains of their bodies are found in the cell after their fully developed enemies have quitted it.

Another parasite appears to commence its attack on the insect itself in one of its more advanced stages. On one occasion I obtained three specimens of this parasite in its pupa-state. I found the pupæ inside the above-mentioned gold-beaters'-skin-like shell, so that the egg must have been deposited through the mud-wall and shell on to the young wasp either whilst changing from the larval to the pupal state or when it had already been transformed into a pupa. The pupæ of these parasites are extremely lively.

SPHEX EPHIPPIUM, *Sm.*

These are underground builders. One which I observed on Nov. 4, 1883, emerged and brought up earth 15 times in the course of 11 minutes. I once saw one pounce upon an insect which I took for a cricket. They cover up the opening of their nest every night when their labours are done. They are not particular as to site, sometimes mining under a shrub in loose garden soil, at others in the hardened ground of a well-trodden, but not gravelled footpath.

LARRIDÆ.

PISON SPINOLÆ, *Shuck.*, and PERPLEXUS, *Smith.*

The nests are exceedingly brittle, and are apparently formed of small particles of loose dry earth stuck together by some gummy fluid secreted by the wasps. They fill their nests exclusively with small spiders, and the larva makes itself a dull grey brittle shell in the cell. [The specimens to which this observation applies appear to represent two species; both probably have similar habits.—W. F. K.]

BEMBICIDÆ.

BEMBEX TRIDENTIFER, *Sm.*

These build underground nests.

DIPLOPTERA.

EUMENES LATREILLII, *Sauss.*

Towards the end of last year (1883) I had an opportunity of observing how these wasps build their nests, at Mackay, Queensland.

As to the choice of position of the nest I was unable to find out what the wasps preferred. The only nests I discovered were in out-houses on perpendicular walls sometimes high, sometimes low, and the presence of man (or bees or other insects) did not disturb them in the least while building. On one occasion I found a wasp building on a door of a shed which was in constant use.

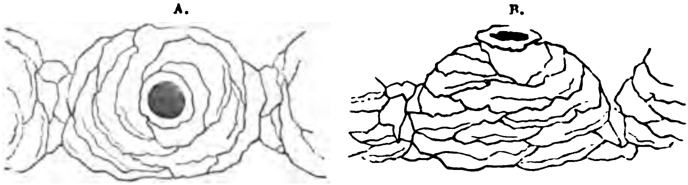
When the wasp has chosen the spot on which she intends to build, she goes in search of water (either stagnant or running), but the particular one which I observed obtained water from the trickling overflow of a leaking pipe. She goes to the water and drinks or rather takes in a supply, and then flies to a clod of not very hard clay-loam. With her mandibles and first pair of legs she scrapes up small particles of the clay, discharging water during

the process. Before long she has made up a little mud-ball about the size of her thorax. This she carries to the chosen site, and commences work by making a little curved wall of mud as the basis of the cell. She then goes back to the water and commences afresh. The distance from the water to the clod was about 12 yards, and from the clod to the site about 4 yards, and it took her from 4 to 7 minutes to get her material, and she would then work from 1 to 2½ minutes. She appeared to have no difficulty in finding her way between the three spots, but occasionally she would try another clod; generally, however, she would come back to the original clod, which had a large and conspicuous moist mark.

Fig. 2, A and B, drawn to scale, gives very accurately the size of the cell as viewed from the side and above; also the various layers of mud as they were deposited, and which are distinctly visible to the last. When the cell was ready the wasp went in search of a common green caterpillar which infested all our vegetables, and put three of these (each about an inch long) into the cell.

Fig. 2.

A. B.



Nest of *Eumenes Latreillii.*—A, upper view; B, side view.

She carries these by the head, holding them with her mandibles and fore legs, and allows the rest of the body of the caterpillar to hang down in a line with her other long legs. She is very particular in packing the caterpillars nicely round the inside of the cell, and, if dissatisfied with her arrangements, she will occasionally take one out and adjust it afresh. When this is done to her entire satisfaction, she deposits one oblong light yellow semi-transparent egg, which is always hung by a light silken thread from the uppermost inside surface of a cell, whatever may be the cell's position. This done, she closes up the orifice with the usual mud, and commences a fresh cell by the side of the completed one. She continues thus daily building the cells, side by side, until she has completed about seven or eight, all in one straight row. She then constructs three or four, side by side, on the top of the first row; and, these being finished, she daubs the whole

over with mud, ultimately giving it the appearance of an oblong lump of clay stuck on the wall, for by well smearing the mud she leaves nothing whatever to indicate the existence of the cells hidden underneath.

This wasp began to build on the 12th of September and finished on the 23rd of the same month, during which period she had completed a nest of ten cells. On the 3rd of November I slightly opened a cell which had been closed on the 20th of September, and found a wasp struggling inside. On the 8th of November I opened some other cells, and found several dead larvæ and pupæ which had been destroyed by parasites.

The cells are furnished with a silvery silk lining, with hardly any space between the lining and the cell-wall. This lining is fixed to the cell by fibres of a woolly appearance. In one corner of a cell, between the lining and the cell-wall, I found what appeared to be the cast-off skin of the larva, and excrements, as well as the skins of the caterpillars which had been devoured.

The wasps do not all emerge from the same side, some coming out at one end of the cell and some at the opposite end.

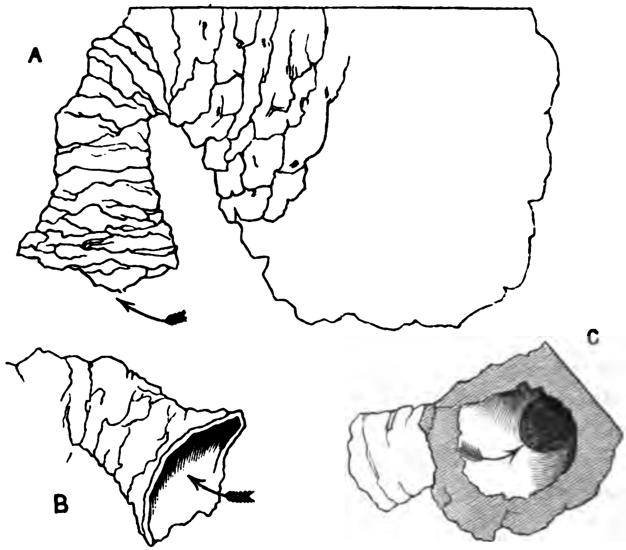
On the 10th of November the wings of the wasp whose cell I had opened had grown to their full length, and on the 12th of November I let her out. She was doubled up, her abdomen being under her thorax, and she was working with her jaws, fore legs, and antennæ, but there seemed to be no room for her to use her other legs. In the corner of the cell, inside the lining, was another cast-off skin. On the same day (November 12) a wasp emerged from a cell closed on the 22nd of September, so that it would appear that it takes fifty-one days for the development of the wasp from the time the egg is laid until the wasp appears as a fully formed imago. Both the wasps on emerging emitted a few drops of a colourless fluid like water, and, strange to say, it appeared to me that this came from the thorax. Both wasps commenced to clean themselves as soon as they emerged, and then prepared to fly away, when I captured them.

ABISPA SPLENDIDA, *Guér.*

I found five specimens of these, which I took out of the nest. The larva and pupa develop without forming any shell. When the female has finished her nest she blocks up the entrance, but whether she destroys the approach or not I am unable to say. Each larva has a cell to itself.

[A short account of the nest of *Abispa ephippium*, Fabr., was published by Smith and Ker, Trans. Ent. Soc. Lond. (2) i. pp. 180, 181 (1850).—W. F. K.]

Fig. 3.



Nest of *Abispa splendida*.
A. Side view, nat. size. B. Outer opening. C. Section showing the inner opening as indicated towards the point of the arrow.

RHYNCHIUM ROTHI, sp. n.

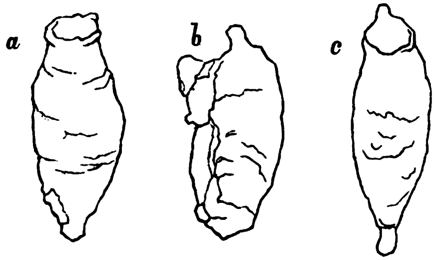
[Exp. al. 13–14 lin.

Female. Black; antennæ reddish, scape paler, bright yellow beneath. Head black; clypeus very finely punctured, wholly yellow, slightly angulated at the sides, rather longer than broad, and bifid at the extremity; base of the mandibles with a slight orange streak; hinder orbits and inner orbits from the clypeus to the depth of the emargination rather narrowly bordered with yellow, the intermediate orbits on the borders of the vertex very slightly marked with orange; vertex and thorax rather coarsely punctured; between the antennæ is a nearly equilateral yellow triangle, and two small oblique orange streaks lie between the two hinder ocelli and the front ocellus. Prothorax entirely yellow above; a small orange dot in front of the base of the

wings; scapulæ black; meso- and metathorax black, the latter with three small spines at the lower angles. Abdomen black, the first segment narrowly, and all the others rather broadly, edged with orange above, and, except the first, narrowly below; the subterminal segment is more broadly bordered with orange beneath; and the terminal segment is entirely orange above, except at the base, and black, with a narrow yellowish rim, below; the orange border of the second segment projects forward on each side above, but the other borders are not perceptibly waved. Front legs reddish; femora black at the base, and with a yellow stripe at the tip beneath; four hind legs red, the greater part of the femora, the tips of the hind tibiæ, and the basal joints of all the tarsi black above. Wings yellowish hyaline, smoky towards the extremity; subcostal nervure blackish, especially at the base.

Male. The light markings of a much deeper colour, of an orange-yellow; clypeus (which is semicircularly emarginate at tip), labrum, and mandibles (except the tips, which are blackish) orange-yellow; upper part of the head almost entirely black; an orange-yellow mark, like a dumbbell, between the antennæ; orbits, from the clypeus to the depth of the emargination, narrowly reddish; cheeks behind the eyes entirely reddish on their lower portion, but this colour rapidly narrows, and ceases entirely at two thirds of the height of the hinder orbits. Prothorax and legs almost entirely reddish orange, the four hinder coxæ only being slightly marked with blackish; on the sides of the prothorax are two reddish spots and a streak, the uppermost and smallest of the spots being in front of the base of the fore wings,

Fig. 4.



a–c. Outlines, nests of *Rhynchium Rothi*, of natural size, and showing the irregularities in shape of nests made by the individual insect.

Metathorax very strongly keeled behind; sides orange, with a very strong obtuse projection. Basal segment of abdomen black at the base, red in the middle, and orange behind, the two latter colours not very sharply defined; a dusky line on the middle above, and a short dusky dash on each side above, near the extremity; the reddish-orange border of the second segment with a small black line in front in the middle, and a slight dusky mark on each side above; the borders of the remaining segments rather more extended than in the female, especially on the under surface. Subcostal nervure of wings not blackish, and tips of the wings less dusky than in the female.

Resembles *Rhynchium mirabile* and *R. superbum*, Sauss., but differs from both in the colour and shape of the clypeus. An unnamed specimen from Torres Straits, in the British Museum, appears to be a slight variety of the female, differing from Mr. Roth's specimen by its darker legs, and in some minute details of coloration on the head and abdomen.—W. F. K.]

The specimens herewith are, I believe, generally supposed to be distinct species, but as I have found them in the same nests, I am inclined to think that they are simply male and female. I believe these insects build nests like those of *Pelopæus lætus* (see fig. 1, p. 319). The cell is provided with a brown silky lining, in which the larva becomes developed. When the larva has shed its skin, the wings develop first, the eyes then gradually turn black, the abdominal bands turn dark as well as the thorax; finally, the legs and antennæ become more defined, and the insect emerges fully developed.

Odynerus bicolor, *Sauss.*

These insects make use of forsaken nests of *Pelopæus lætus*, Sm.

Vespidæ.

Polistes Bernardii, *Le Guillon.*

These wasps build paper-like nests, suspended by a black stalk, and without any envelope. They feed their larvæ with a peculiar light yellow substance, which they collect in large lumps. A wasp, on arriving at the nest, shares this with the other wasps, who immediately set to work to feed their progeny. It is very droll to see the larvæ put forth their heads and greedily devour the food offered them.

Heterogyna.

Formicidæ.

Formica rufonigra, *Lowne.*

These ants are very numerous and destructive at Mackay, Queensland, and attack anything and everything that comes in their way. They are not even afraid of the large species of *Camponotus*, some of which, when attacked, remain perfectly still, with a firm grip on the ground; but this passive resistance avails them nothing, for they are mercilessly dragged off all the same.

A tree in my garden (Chinese date-plum?) was infested to a great extent by green caterpillars, which appeared to feed at night-time, resting during the day under a web spun across a leaf. These ants discovered the tree, and cleared it of the caterpillars. Although they would sometimes enter the web to inspect it, they never attacked the caterpillar without first destroying the web, when they would bite the caterpillar till it wriggled out and fell among the ants below, who carried it off. These ants had numerous holes, communicating by pathways above ground, if not by subterranean galleries also, throughout the garden. They are one of the most abundant species of ant; and when alive are of a much blacker colour than when they have been preserved in spirit. They also milk the "waxy white louse" (pou à poche blanche) which infests the sugar-cane.

Œcophylla virescens, *Fabr.*

They take possession of whole trees, gumming up the leaves for their nests with a white semitransparent sort of paper. They rob beehives, not for the honey, but for the bees themselves. They go to the hive and attack the bees on their arrival. The latter have no chance against the numbers of the ants, and are stung to death and carried triumphantly off to the nests. These ants are very fearless and bold in attacking any one, and are armed with a very painful sting. I have seen them attack a *Curculio*, but the latter remained perfectly still till the ants left it, probably supposing that it was dead or unfit for food. If any one approaches a tree on which these ants are resting, they raise the front part of the body in a menacing manner. They are found on various trees, *Eucalyptus*, orange, &c., at Mackay, Queensland.

[Jerdon (Ann. & Mag. Nat. Hist. (2) xiii. pp. 104, 105—1854) gives a similar account of the nests of the allied Indian ant, *Œ. smaragdina*, Fabr., and says that although they feed chiefly on vegetable secretions, they are sometimes employed to destroy a nest of wasps that may have established themselves in a house. He does not speak of their attacking bees.—W. F. K.]

PONERIDÆ.

ECTATOMMA DIMINUTA, *Smith*.

These marauding ants from Cairns, Queensland, appear to have no settled home, but roam about in masses, sometimes together and sometimes separating into small companies. They attack any insect they meet with, hunting their victims from under the bark of dead trees or out of crevices. Nothing comes amiss to them, and no insect appears to escape them.

CRYPTOCERIDÆ.

MERANOPLUS DIMIDIATUS, *Sm.*

These harvesting ants are found at Mackay, Queensland. They climb up grasses, and carry away the seed to their nests. The ground near the nest is generally strewn all over with the husks they have brought to the surface.

Ornithological Notes.

By THOMAS EDWARD GUNN, F.L.S.

[Read 15th January, 1885.]

Occurrence of the Blue-throated Warbler on the Norfolk Coast.—During the past four autumn seasons Mr. G. E. Power has been fortunate in procuring specimens of this hitherto rare British species at Cley on the Norfolk coast. In the second week of September last (1884), the Blue-throated Warbler apparently arrived in larger numbers than usual, so that Mr. Power had a chance of securing a good series for his collection; he having sent me a dozen examples to preserve, afforded me an opportunity of making a few observations, which I now append.

The relative lengths of the bills and tarsus in the above, with one exception, varied so slightly as to be scarcely perceptible,

No.	Sex.	Total length.	Extend. wings.	Wing-carpus.	Bill.	Tail.	Tarsus.	Weight.
		inch.	inch.	inch.	inch.	inch.	inch.	
1.	♂	$6\frac{1}{8}$	...	$3\frac{1}{8}$	$\frac{7}{16}$	...	1	
2.	♂	$6\frac{1}{8}$	$9\frac{1}{4}$	$3\frac{1}{8}$	$\frac{7}{16}$	...	1	
3.	♂	$6\frac{1}{4}$	$9\frac{5}{8}$	$3\frac{3}{16}$	$\frac{7}{16}$	$2\frac{1}{2}$	$1\frac{1}{16}$	
4.	♀	$6\frac{1}{4}$	$9\frac{1}{2}$	$3\frac{1}{8}$	...	$2\frac{3}{8}$	1	
5.	♀	$6\frac{1}{4}$	$9\frac{3}{8}$	$3\frac{1}{8}$	...	$2\frac{3}{8}$	...	240 grs. or $\frac{1}{2}$ oz. apoth. wt.
6.	♀	$6\frac{3}{8}$	$9\frac{1}{2}$	3	...	...	...	255 grs.
7.	♂	$6\frac{1}{8}$	$9\frac{1}{2}$	3	...	...	...	220 grs.
8.	♂	$6\frac{1}{4}$	$9\frac{3}{8}$	3				
9.	♀	$6\frac{1}{8}$	$9\frac{1}{8}$	3				
10.	♀	$6\frac{1}{4}$	$9\frac{1}{2}$	$3\frac{1}{8}$				
11.	♂	$6\frac{1}{8}$	$9\frac{1}{8}$	3	...	$2\frac{1}{4}$		
12.	♀	$6\frac{1}{4}$	$9\frac{1}{4}$	$3\frac{1}{8}$	...	$2\frac{1}{4}$		

those of the first five if anything having the advantage. Nos. 1 to 5 inclusive had blue throats, and were probably birds of the previous year, although not fully adult. Nos. 6 to 12 inclusive were evidently birds of the year, and showed no trace whatever of the blue throat. In nos. 1, 2, and 3, all males, the irides were dark brown; the head, back, and upper surface of wings clove-brown, the feathers of the crown had a darker centre, and those of its wings with pale outer edges; the streak over the eye of a dirty white, assuming a rufous tint from the eye to base of bill; the markings of the throat and neck varied considerably, a black line of feathers, either more or less broken, extended from the gape down each side of its neck, meeting a bar of blue that crossed the chest; below this a fine line of black, then a band of deep bay. The bar of blue in no. 1 was narrow and intermixed with black; space below ear-coverts dirty white, tinged with buff, and mixed with a few pale-blue feathers; the throat was white, with a narrow bar of bay just above the blue in one, a deeper bar in another, and in the third the throat all bay, excepting just under the chin, which was dirty white. The two females, nos. 4 and 5, had also blue bars across the chest, which were paler in hue, and broken up with some dark feathers, and were therefore not so sharp and distinct as in the males. In the 7 younger birds the chin and throat were white, the black feathers extending from each side of its neck and across the chest in form somewhat resembling a horseshoe. The tail-feathers, excepting the two centre ones, had the basal half of a bright bay, the rest dark clove-brown: under tail-coverts pale rufous; belly greyish white, with rufous tinge; flanks greyish brown; legs and toes brown.

In dissection I found the whole of their stomachs to contain,

either in more or less quantity, the remains of small Coleoptera; in that of no. 1 were as many as 7 individuals; the testes of this bird were very small, and of a dark-brown colour, nearly black. In the stomach of no. 10, in addition to the Coleoptera-remains, were two empty skins of a small lepidopterous larva.

Little Bittern in Hertfordshire.—This immature specimen of the Little Bittern (exhibited at the Meeting) was sent me on the 15th of October, 1884, by Mr. E. N. Benningfield, of Broxbourne Bridge, Herts, he having shot it himself two days previous in the Sea-marshes at Broxbourne. It was turned out of the sedges at the side of the river by his dog. On dissection it proved to be a female, the ovarium being small. The body was exceedingly fat, and in its stomach were the remains of aquatic insects, and the tail portions of two small fish, one of which I recognized as a perch; it also contained some bits of reed and vegetable fibres, these being, no doubt, accidentally swallowed with its prey. The following are the exact measurements that I took previous to skinning it:—

	inches.
Total length from tip of beak to end of tail	15½
Tip to tip of fully extended wings	22
In the wing from carpal joint to tip of longest primary	5¾
Bill along ridge of upper mandible	1⅞
Tarsus	1¾
Tibia	3
Middle toe and claw	2
Outer toe and claw	1⅝
Inner toe and claw	1¼
Hinder toe and claw	1⅜
The inner edge of claw of middle toe is serrated.	
Tail	2
Weight (Avoirdupois)	4½ oz.

The second primary-feather in the wing was the longest, the first and third of equal length, and rather less than the second, the fourth and fifth and the remainder in succession each rather less than the preceding one. The irides of a pale straw-yellow, with a fine circle of paler tint around the black pupil. The ridge of its upper mandible was dark horn, the sides paler, merging into a greenish yellow from the nostril to the gape; under mandible of a pale horn, with a greenish-yellow tinge at gape; circle around the eye yellowish green; a stripe of pale brown in front of the eye divided the circle from the gape; tongue and mouth flesh-colour. Legs and toes yellow-green; under surface of toes and back of tarsus lemon-yellow. This description

of legs and toes does not at all agree with Yarrell (1 ed. vol. ii. p. 474); he says these parts are reddish brown, but he probably gave his description from a dried specimen. The only previous example of the Little Bittern I have ever received in the flesh or fresh state was also an immature female; this was killed on the Lower Abbey Marshes at Leiston in Suffolk, on the 25th of August, 1882. The measurements of this bird corresponded almost exactly with those given above. The weight, however, was 5 ounces, being ½ an ounce more; this can easily be accounted for by the contents of its stomach being of greater bulk; it consisted of aquatic insects, and two small pike, quite entire, each measuring 3¾ inches in length. The plumage of this bird was somewhat darker than the Suffolk specimen.

Hybrid between a Goldfinch and Bullfinch.—This interesting hybrid died at a Canary Show in Norwich, on the 4th of November last. It had been exhibited by Miss Howison of Cheltenham. It was bred early last season from a cock Goldfinch and hen Bullfinch, and was therefore not quite a year old. It weighed 4 drms. (apothecaries' weight); measured 6¼ inches in length from tip of beak to end of tail, 9¾ inches across fully-extended wings to tip of each, and 3¼ inches in the wing from carpal joint to tip of longest primary; tail 2½ inches. It showed certain characteristics of both parents, and was nearly the size of the Bullfinch, but somewhat slender in build, the back, wings, white rump, and tail resembling that bird; the tips of the secondaries in the wing were of a yellowish buff, instead of a slaty grey; the tips of the two long feathers of its upper tail-coverts were slaty grey, similar to those in the Goldfinch, and the outside feather of each side of its tail had a patch or blotch of white on the inner web; the Goldfinch had the two outer feathers similarly marked, the second feather having a much smaller patch or blotch; all the feathers in the tail of the Bullfinch were quite plain. The crown of its head was black, and the face of the Goldfinch was represented by the red being of a more delicate tint, which colour was suffused over its throat and chest, merging into a reddish-orange hue on the latter, also extending in a crescent-form from the lower part of its black crown to side of its throat; the ear-coverts were grey; abdomen and under tail-coverts white; flanks ash-grey; legs and toes pale horn. The beak was a modification of that of both parents, with a fine point to its upper mandible, extending $\frac{1}{16}$ of an inch beyond the lower; colour pale horn, nearly black at tip.

The Morphology of *Cyclops* and the Relations of the Copepoda.

By Marcus M. Hartog, D.Sc., M.A., F.L.S., Prof. Nat. Hist., Queen's College, Cork.

[Abstract *.—Read 19th June, 1884.]

This paper opens with a full anatomical description of *Cyclops brevicornis*, Claus, worked out in great part by the method of sections. The chief new points made out are as follows:—In the skeleton a free entosternite is demonstrated in the maxillary region, and homologized with the tendon of the adductors of the valves of the bivalve Entomostraca. A large postmaxillary apodeme in all Copepoda gives attachment on either side to the great flexors of the trunk. A spring arrangement is shown to relax the flexed male antennule used as a clasper. Pore-canals, cells, or cutaneous glands each receive a nerve-fibre at their proximal end. The hypodermal cells have a polygonal outline.

Under the mesoblastic tissue, Frič's discovery of amœboid cœlomic corpuscles is confirmed. The apparatus of deglutition is fully described, and the author has made out a pair of salivary glands in the epistoma, whose ducts join to open on the back of the labrum by a median pore. In connection with the alimentary canal, the mechanism of circulation and anal respiration is described, the efficiency of the latter being strongly maintained.

The kidney, or "shell-gland," is shown to be a simple, much-coiled tube, with chitinous lining, opening at the base of the outer maxilliped. Incidentally the presence of this organ is noted in several divisions of the marine Copepoda, and the author suggests that it is *identical* with the "antennary gland" of similar structure of the Nauplius larva, which would have shifted its aperture.

A full description of the nervous system follows. The presence of ganglion-cells in the circumœsophageal cords is noted, and used as an argument for regarding the (2nd) antennæ innervated therefrom as oral rather than postoral appendages.

The presence of corneal facets to the lateral ocelli is noted, and an attempt is made to connect what the author has described elsewhere as auditory organs with the unicellular pore-canal glands.

The views of Gruber on the reproductive organs are confirmed,

* This paper will appear in the Transactions with appropriate illustrations.

The sexual ducts are described as outgrowths from the sexual glands, themselves derived from a pair of cells of the serosa of the gut of the Nauplius as stated by Frič. About 32 spermatozoa appear to be formed from each male ovum or spermatospore. The author is inclined to accept Gruber's view that the expulsive bodies of the spermatophore are a second form of spermatozoa.

The author then proceeds to a discussion on the position of the Copepoda. He adduces the following points:—

(*a*) The plasticity of the eye, derived from the triune inverted eye of the Nauplius, and the absence of paired compound eyes.

(*b*) The *biramous condition of the swimming-feet*, and the *characters of the appendages generally*, especially the *plasticity of the maxillæ.*

(*c*) The *slight development of the pleura.*

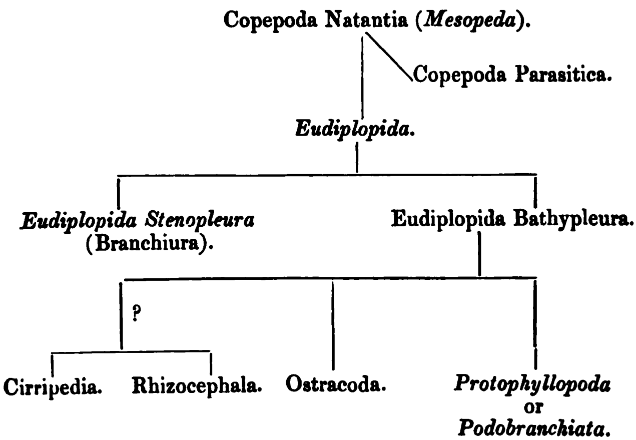
(*d*) The *absence of gills*, and the *functional anal respiration.*

(*e*) The plasticity of the fore part of the alimentary canal.

(*f*) The circulation and heart.

(*g*) The general correspondence of the form of the body with that of the Protozoëa and Zoëa larva.

By converging arguments from these points, it is shown that Copepoda would represent the most primitive Crustacea, from which the others can be derived according to the following phylogeny:—



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